RAILROAD GAZETTE

FRIDAY, JANUARY 18, 1878.

Friction, Lubrication and Lubricants.

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[Abstract of a lecture delivered at a meeting of railroad men in the rooms of the Master Car Builders' Association, New York, at the request of a committee, Dec. 20, 1877.]

In what I have to say this evening, you will recognize many familiar statements and may perhaps hear little that is new; but I shall endeavor to tell a very straight story, and fear that, were I to drop the best-known links from the chain of my argument, I might lose those which are less familiar if not more important.

Friction is a resistance which is always met when two bodies or particles, whether solid, liquid or gaseous, are compelled to move, one upon another. There are three kinds of friction, so called: rolling and sliding, with solids, and fluid friction with liquids and gases. These are all governed by different laws, and, with each, the statements of those laws, as usually given in the text-books, require modification.

I need say little of rolling friction, as that form of resistance does not come properly within the province of this lecture. It will be enough to say that Coulomb was the first to determine its law and that he found that, so long as the wheel or roller and the surface on which it rolled were not injured, the resistance was proportional to the weight and diminished as the diameter of the wheel increased.*

In all ordinary cases, as of journals in well-lubricated bearings, the friction probably combines both the other forms of resistance, and, consequently, the laws of friction as determined by experiment upon journals and as affecting journals are quite different from the laws of friction of solids which are almost universally enunciated in handbooks and text-books.

As ordinarily stated, the co-efficient of friction, or *the ratio of frictional resistance to the total pressure* holding two sliding solids in contact, and which is the usual measure of friction, varies directly as the pressure and is independent of the velocity of motion and of the area of the surfaces in contact.

The "friction of quiescence," or the resistance to starting the two bodies into relative motion, is greater than the "friction of motion;" but it is subject to the same laws. The law just stated is subject to limitation. It becomes untrue when the pressure is so great as to produce a depression, or to abrade the rubbing surfaces.

The friction becomes greater than is indicated by the stated law, when the pressure becomes so low, also, that the resistance is principally due to the viscosity of the interposed liquid, and then follows an entirely new law. Between these limits the resistance due to friction between solid *lubricated* surfaces is of a mixed nature.

Fluid friction is found to vary with the square of the velocity, and is probably independent of the pressure. In hundreds of experiments with pressures varying from 5 to 275 pounds to the square inch, I have found the friction of well lubricated journals to vary in such a manner as to prove that the law which governs such cases is quite different from that which applies with dry solids.

There are two usual ways of measuring friction, and of determining the co-efficient for solids, which are described in the books:

First.—Place the two bodies in such a position that the rubbing surface shall be horizontal; load the upper one to the proposed extent, and then apply a measurable force to produce motion, either by means of a weight or of a spring balance. The weight of the uppermost piece with its load makes up the quantity P, and the applied force is F. The "co-efficient" of friction is the ratio of these quantities, and we have $f = \frac{F}{P}$.

This value f may be less than one per cent., or it may be 50 per cent., according to the nature of the materials and their condition as respects lubrication.

The other method is equally easy of application. Lay the one solid on the other and tilt them up until the upper will slide on the lower. The tangent of the angle is the co-efficient of friction, and we simply measure the height of a point in the surface on which sliding occurs, and the horizontal distance of the vertical from a point in the same surface which lies on a level with that to which this height was measured, and the division of the latter by the former measurement gives the value of the co-efficient of friction.

The value of a lubricant to the consumer depends on its cost in the market, its efficiency in reducing friction, its durability under wear, its freedom from liability to "gum," its freedom from acid and from grit, and its permanence of composition and of physical condition when subjected to changes of temperature, and also, frequently, its capacity for carrying away heat from journals already heated.

Thus, sperm oil is known by all experienced mechanics, and by all dealers in oil, to be one of the very best of known lubricants; but its high price precludes its use, except for special purposes. Some other oils are cheap, but have little lubricating power; still others are good reducers of friction, but do not wear well, or frequently cannot be retained on the journals; others, as linseed and the drying oils, generally, gum so seriously that they cannot be used for lubrication; while a good deal of the tallow in the market and some other lubricants contain acids of decomposition, or acids which have been used in their clarification, and which have not been so completely removed as to prevent injury by their action on the metals. Some lubricants cannot be used at low temperatures because they are liable to congeal, and others cannot be used in steam cylinders or where high temperature is liable to be met with because they decompose or vaporize under such circumstances.

Every dealer in oils and every consumer of lubricants who desires to know with certainty whether he has, in any case, precisely that lubricant and that quality which is nominally given him must resort to some method of identification of the material. Every user of such a material who desires to know whether it is well adapted to a specific purpose, or who wishes to find out what are its peculiar characteristics, must find some method of testing it, and of thus ascertaining whether, under the conditions arising in his practice, it will serve his purpose. He must know whether it will bear the pressure, and run on his journal at the speed, to which he must subject it.

It is sometimes sufficient for the user of an oil to identify it and to be able to detect adulterations. Sperm and lard oils, for example, are standard lubricants; and if the consumer or the dealer can assure himself that the oil which he has in hand is pure sperm or pure lard, that is often enough, since long experience may have taught him that this oil, and no other, is likely to fully answer his purpose. Cases do sometimes occur in which the purchaser of an oil does not care to try if other less well known oils may not meet his wants quite as well and at lower cost.

The tests for identification are chemical and physical. The chemist can sometimes, by applying "reagents," which have peculiar effect on an oil, determine whether that oil is sperm, or lard, or other, and detect adulterations. This is, in some cases, quite easy to do and tolerably certain, since there are usually very few oils of which the cost would be low enough to permit their use as adulterants. For example, the chemist would look for cotton-seed oil, perhaps, in his tests of so-called *pure* lard oil, since that, in the present condition of the market, is about as likely to be used as an adulterant of lard as any other oil. This kind of test would rarely be used, except by an expert chemist, and I need not attempt to describe such methods in detail here.

Perhaps the simplest and easiest method of identifying a standard oil, although by no means a certain one, is the determination of its density or its specific gravity. This may be done by carefully weighing an exactly measured volume of the lubricant and comparing its weight with the standard volume of a standard substance, or by the use of the "densimeter," or oleometer. This little instrument, generally known as the hydrometer, takes its name from the application for which it has been designed, as, for example, lactometer when used to determine the density of milk, and alcoholometer when used to measure that of alcohol.

It is a glass cylinder (showing it, fig 1), about ¾ or ⅞ inch

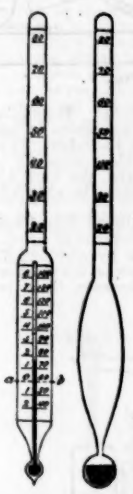

Fig. 2. Fig 1.

in diameter, and 4 or 5 inches long, and having at one end a bulb loaded with shot, and at the other a small cylindrical stem suitably graduated.

Placing this instrument in a liquid, it floats upright, with the loaded end downward, and sinks to such a depth that the figure on the stem reads the density or the specific gravity (the terms are not precisely synonymous) of the liquid.

In using this instrument the liquid must have the standard temperature, say 60 degrees, as its density is considerably affected by heat or cold. Another form of hydrometer is that shown in fig. 2, which has a thermometer attached to the lower end. This is intended to assist in making corrections for a temperature above or below 60 degrees. When the thermometer indicates a temperature above 60, which is shown by the figure on the right side, the corresponding number opposite must be added to the indications on the scale above. If the thermometer stands below 60 degrees, the corresponding number opposite must be deducted.

The specific gravity of any substance is proportional to its density, and is the ratio of the weight of a given volume of the substance to that of an equal volume of water, both being taken at the temperature of maximum density of the latter. The density may also be measured by any other standard. These oleometers are often—in fact, usually—graduated by the system of Beaumé, in which $\frac{140}{130 + \text{Beaumé}} = \text{specific gravity}$, and $\frac{140}{\text{sp. gr.}} - 130 = \text{B}°$, the reading of Beaumé.

Now, determining the gravity of an oil, sperm, for example, and finding it to be 0.8750, or 30° Beaumé, it would be at once concluded to be impure; because sperm should give about 0.8810 or 0.8815, corresponding to 29 B.

The following are the figures for some standard oils:

	Sp. Gr.	B.		Sp. Gr.	B.
Castor oil	0.9640	15	Rapeseed	0.9155	23
Linseed oil	0.9300	21	Neatsfoot	0.9142	23
Menhaden	0.9300	21	Colza	0.9136	23
Cotton seed	0.9302	21	Palm	0.9046	25
Whale	0.9254	21	Sperm	0.8815	29
Olive	0.9192	22	Heavy mineral	0.8800	28
Lard	0.9175	23	Light "	0.8000	45

Weighing can be made to give more accurate determination than the oleometer.

The temperature of decomposition of the mineral oils is a good gauge of their values. An oil should not generally be used which takes fire at so low a temperature as 250 Fhr. Some of the best oils do not burn, or even give off much vapor at a temperature of 300° or more. This "fire test" is usually made with a little piece of apparatus made especially for the purpose. This one, fig. 3, (showing one) consists of a little tank, in which the oil to be tested is poured. This is placed in another large cup, B, and the space between is filled with water for ordinary tests. A lamp beneath supplies the heat, and a thermometer, T, set in the cup, with its bulb in the oil, shows the temperature.

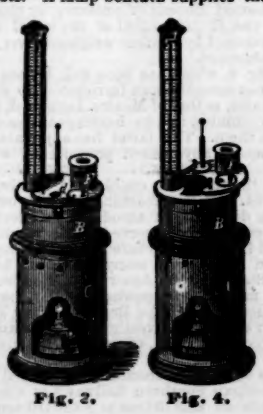

Fig. 3. Fig. 4.

As the oil becomes heated, the observer occassionally applies a lighted match or taper to the opening, C, of the cup. After a time a flash is seen when the match is applied, and the flame disappears as suddenly as it has appeared. This shows that vapor has been produced in sufficient quantity to mix with the air above the oil, and produce an explosive mixture. The temperature now observed is called the "flashing point." At some higher temperature, if the cap is moved to one side, as shown in fig. 4, and a match is applied, the oil takes fire and burns. This is the so-called "burning point." It may be 20 degress or more above the flashing point.*

Still another, and a very beautiful, although rarely practiced, method of identifying oils of various kinds is that introduced some years ago under the name of "oleograph tests." We proceed thus: Wash out a large basin very carefully with water and alkali until it is chemically free from foreign matter and fill with perfectly clean water. When the surface has become quiet, drop upon it a single drop of the oil to be examined. The oil at once spreads rapidly over the surface of the water in an exceedingly thin film. Presently the film commences breaking up, small openings appearing through it, which gradually enlarge and group themselves into peculiar lace-like patterns. These lace-patterns continue changing, and finally the surface of the water is covered with detached and very minute particles of oil. Each oil, under the same set of standard conditions, exhibits a peculiar behavior that is always characteristic of the oil and which can therefore be made of use in identifying it. Each oil spreads at a certain rate, and each, at a given instant during the process of change, forms a peculiar lace. A comparison of the pattern produced in testing the several oils and of the times of observation enables the experimenter to judge, by comparison with his standards, whether the oils tested in this way are pure or adulterated.

In doing this work it is important to be able to secure copies of the patterns thus obtained. This is done by a very simple and neat process: Provide another basin containing water rather strongly colored with ink and a quantity of white blotting paper cut into pieces of such size and shape that they can be laid upon the surface of the water in the testing-basin.

The observer stands, watch in hand, noting the changes progressing in the film of oil. At the proper moment—a half minute, a minute or two minutes, whichever may have been found a proper standard time, measured from the falling of the drop—he carefully and quickly lays a piece of his blotting-paper down on the film; then as quickly and carefully transfers it to the surface of the ink solution. At the first contact every point in the surface transfers to the pages a particle of water or a particle of oil, and the lace pattern is now present on the paper in oil and water. On placing the blotting-paper on the colored water, all parts of the surface unprotected by oil are stained, while the rest remains uncolored, and the beautiful lace pattern appears in black and white in permanent and preservable form. The sheet is next marked with the name of the oil, the date of the test and the time allowed for the formation of the pattern. It still remains to be determined by further experiment how far the method may be made practically valuable and reliable.

In order to determine precisely what oils are adapted to any special purpose, or to ascertain for what uses any oil is best fitted, it is always necessary to make an examination of the lubricant working under the specified conditions. That is to say: the oil should be put upon a journal of the character of that on which it is proposed to use it, and, subjecting it to the maximum pressure proposed, running it at the maximum speed that the journal is ever expected to attain, its behavior will then show conclusively its adaptability to such an application. While running, it is necessary to be able to measure the friction produced and to determine its co-efficient, which, as we have seen, is its measure, and to be able to note its durability and the rise in temperature of the bearing. These qualities being determined and recorded, all is known of the oil that is needed to determine its lubricating power.

The flashing and the burning points or the temperature of decomposition can then be found, and thus its liability to injury by heat determined, or its safety in the presence of fire; and a determination of its temperature of thickening or congelation will show whether it may be used for out-of-door applications in cold climates. The standard animal and vegetable oils and all mineral oils of good "body" and density only decompose or vaporize at a temperature exceeding that of the steam in ordinary steam engines, and the latter sometimes, and the former two usually, bear even steam at locomotive pressure. The good mineral oils do not congeal at any ordinarily low temperatures, the heavier oils freezing at 20° F. and the lighter remaining liquid at 0°. Summer sperm thickens at about 65° F., freezing at about 50°, winter sperm at about 50° and 35°; and lard oil begins to harden at 40°, solidifying at 25° F.

Nasmyth uses a very simple method of determining the viscosity and the rate of "gumming" of oils. He places a drop at the top of an inclined plane and notes the time required for it to run down the plane. Of oils which do not gum, the least viscous reach the bottom first. Drying and gumming oils are retarded in proportion to the rate of drying or of gumming.†

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* Coulomb found $R = f\frac{P}{r}$, in which R is the resistance applied at the circumference of the wheel, P the total weight, r the radius of the wheel and f a co-efficient which is very variable and equal to as much as 0.03 for wood and 0.006 for metal.

* This instrument is manufactured of two different sizes by Mr. G. Tagliabue, No. 302 Pearl street New York.

† The following description of this method of testing oil is from Appleton's Dictionary of Mechanics, Vol. II., page 450.

The oil test, which is an invention of Mr. Nasmyth's, consists of a plate of iron, 4 in. wide by 6 feet long, on the upper surface of which six equal-sized grooves are planed. This plate is placed in an inclined position, say one inch in six feet. The mode of testing is as follows: Suppose we have six varieties of oil to test, and we are desirous of knowing which of them will, for the longest time, retain its fluidity when in contact with iron and exposed to the action of air; all we have to do is to pour out *simultaneously* at the upper end of each inclined groove an equal quantity of each of the oils under examination. This is very conveniently and correctly done by means of a row of small brass tubes. The six oils then make a fair start on their race down hill: some get ahead the first day, and some keep ahead the second and third day, but on the fourth or fifth day the truth begins to come out; the bad oils, whatever good progress they may have made at the outset, soon come to a standstill by their gradual coagulation, while the good oil holds on its course: and at the end of eight or ten days there is no doubt left as to which is the best; it speaks for itself, having distanced its competitors by a long way. Linseed oil, which makes capital progress *the first day*, is set fast after having traveled 18 inches, while second-class sperm beats first-class sperm by 14 inches in nine days, having traversed in that time 5 ft. 8 in. down the hill. The following table shows the state of the oil race after a nine days' run:

RESULTS OF OIL TEST.

Description of Oil.	First Day	Second Day	Third Day	Fourth Day	Fifth Day	Sixth Day	Seventh Day	Eighth Day	Ninth Day
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in	ft in	ft in	ft.in	ft.in
Best sperm oil	2.8½	4.2	4.5½	4.6	4.6	4.6	4.6½	stat.	.....
Common sperm oil	1.7	3.9	4.6½	4.11	5.1½	5.4	5.6½	5.7½	5.8
Galliopoli oil	0.10½	1.2½	1.6	1.6½	1.7½	1.8½	1.9	1.9½	1.9½
Lard oil	0.10½	0.10½	0.10½	0.10½	0.11½	stat.	.....	.....	.....
Rape oil	1 2½	1.6½	1.7	1.7½	1.7½	1.7½	1.7½	1.7½	stat.
Linseed oil	1.5½	1.6	1.6½	1.6½	1.6½	1.6½	1.6½	stat.	.....

For some special purposes, certain mixtures are used, as, for cooling hot journals, mixtures of oil and of white or black lead, oil and sulphur, or greases composed of oil to which some alkaline water has been added. I have, in my experience with very large and troublesome marine engines, found sulphur and oil on the journal with the application—very cautiously—of cold water externally, to work best.

For a railroad grease I think a mixture of equal parts of tallow and palm-oil, with water to which ¼ pound of caustic soda to the gallon has been added, a good one, mixing them pretty warm. Two parts paraffine, 1 of lard and 3 of lime water is said to be a good grease, too, especially for heavy, slow-moving journals.

In some cases, a solid lubricant, as powdered plumbago, will be found the only lubricant capable of sustaining the pressure.

Metalline is another form of solid lubricating material, which answers well and saves the annoyance and expense of oil, under some conditions of wear which forbid the use of other lubricants.

Where no other expedient serves, hollow brasses through which water is circulated will usually conquer even very serious cases of badly proportioned journals.

The character of the surfaces of the journal and bearing has an important influence upon their behavior. Cast-iron surfaces are usually less satisfactory than good wrought iron, and homogeneous and moderately soft steel is vastly better still. A pressure of 800 pounds to the square inch can rarely be attained on wrought iron at even low speeds, while 1,200 pounds is not infrequently adopted on the steel crank-pins of steamboat engines. I have known of several thousand pounds pressure per inch being reached on the slow-working and rarely moved pivots of swing bridges. In my own practice, I never, if I can avoid it, use higher pressures than 600 and 1,000 on iron and on steel, and, for general practice, make the pressure less as the speed is greater.*

The method of supplying the lubricant has an important influence on the economy of its use. A perfectly uniform supply of the minimum safe quantity enables an economy to be attained which is surprising to one who has not measured the quantity of oil used. Some years ago, a distinguished firm of tool-builders—Messrs. Sellers & Co.—told me that the hangers of their line-shafting were working perfectly with but 34 drops of oil each per week.

I have often used a wire bent into syphon-shape and loosely wound with lamp-wick, in the old-fashioned oil cups. A little

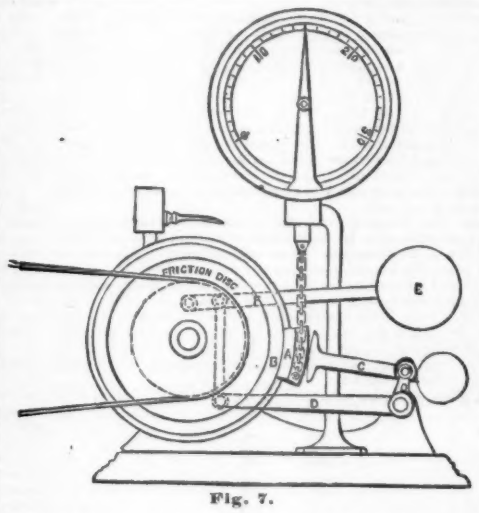

Fig. 7.

is turned by a pully on its spindle. The oil is interposed between the disks, and the friction causes a tendency on the part of the loose disk to turn with the other. This tendency is resisted by a pin on its upper side coming in contact with the short arm of a bell-crank lever, the long horizontal arm of which carries a weight, which can be adjusted to measure the friction.

[Fig. 5 is a side elevation, with the disks *C* and *D* shown in section, and fig. 6 is a plan. It consists of a disk, *D*, attached to a shaft, *A*, which is driven by a pulley, *B*. On top of *D* is another disk, *C*, which can turn on the shaft or spindle *A*. The oil to be tested is placed between these two disks. As the loaded properly. It is fitted with a counter and a thermometer, and the power required to drive it is measured by a dynamometer. Some good work has been done on this machine.

Still another is that of Mr. Hodgman (figs. 9, 10 and 11) which has been brought in this evening. It consists of a McNaught arrangement of disks, to which a counter and a thermometer have been added, and also two spring balances to give the pressure of the test and the resistance due to friction.

[A side elevation of this machine, representing some of the parts in section, is shown by fig 9, a front elevation by fig. 10, and a plan by fig. 11. It consists of a horizontal plate, *A A*, figs. 9 and 10 attached to a vertical shaft, *B B*, which is driven by a pair of mitre wheels, *C* and *D* the latter attached to the horizontal shaft *D E*, on which are a tight and a loose pulley, *F* and *G*, which are driven by a belt. The plate *A A* has an annular groove or receptacle in top, in which a corresponding plate, *H H*, bears. This plate is attached to the shaft *I I* so that they will turn together, but the shaft is fitted into the plate somewhat loosely, so that the plate *H H* can always bear on *A A* uniformly all round and not be constrained by the shaft *I*. The oil to be tested is placed in the annular groove between the two plates, or in an oil-cup, *a*, attached to the top plate. On top of the shaft *I* a lever, *J J'* bears on the centre *J*. Any desired pressure can be brought upon the lever and shaft, and through the latter upon the plate *H H*, by means of a spring balance, *K*, which can be screwed down to any desired pressure by a thumb-screw, *b*. It is obvious that if a pressure is brought to bear on the two plates, as the lower one revolves, the friction between them will tend to turn the upper plate and the shaft *I* to which it is attached. This motion will be resisted by a lever, *L L'*, (shown in plan below fig. 10) with a sector, *c c*, on the outer end. This lever is attached to the upper end of the shaft *I I*. A cord, *L' f*, is attached to the sector at *c* and wound around its outer edge, and it then passes over a pulley, *e e*, and passes downward and is fastened at *f* to another spring balance, *M*. It is evident from this description that when the machine is put in motion the friction between the two plates will cause the upper one to turn, and this by means of the lever *L* and the cord *L' F* will raise the spring balance *M* until the resistance of its spring is just equal to that of the friction between the plates. In this way the indications of *M* will always measure the friction between the plates and that due to the oil which is placed between them to be tested.

A thermometer, *T*, is attached to the upper plate *H* to indi-

Fig. 9

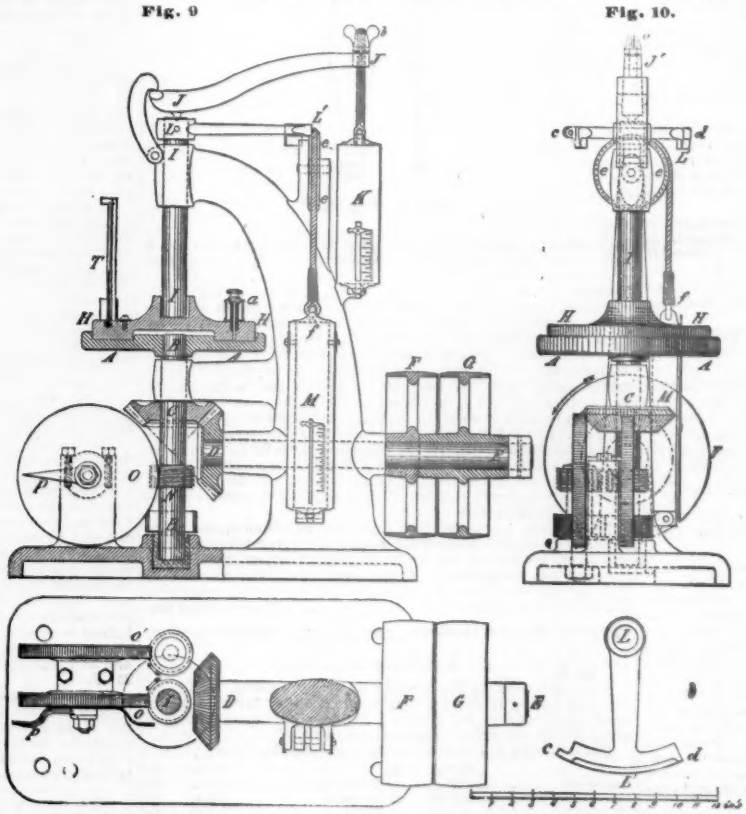

Fig. 10.

Fig. 5.

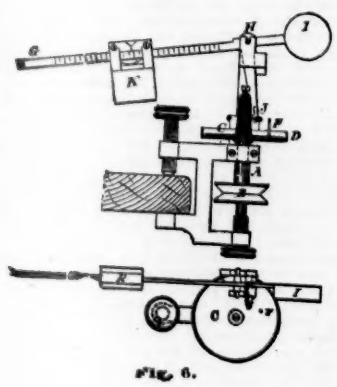

Fig. 6.

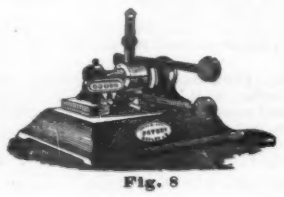

Fig. 8

Fig. 11.

experimenting determines just how many strands of wick should be used and just how low the oil can be permitted to run down in the cup and the minimum expenditure is thus reached.

The later cups of Dreyfus and others are, if properly fitted, similarly economical. My syphons were always removed when the engine was stopped for any length of time, to prevent expenditure of oil when it was not needed. Another good arrangement for very large and important journals is an oil pump taking oil from a reservoir into which it returns from the journal. Self-oiling boxes are still another and a more familiar device.

From what has already been said, it is seen that what is a good lubricant for one purpose is not necessarily good for another. Water is valuable on the lignumvitæ sheath in the stern-bearing of the screw-shaft of a steamer, or on the wooden step of a turbine water-wheel, and answers an excellent purpose in the "*palier-oliasant*;" and it is the best substance known to absorb and to convey away heat; but it is not a true unguent and could not be used as such on ordinary journals.

Plumbago, tallow and castor-oil have the "body" needed for extremely high pressures; and sperm-oil is the best known lubricant for general purposes; but only an oil having the purity and limpidity of watch-oil will answer for watch-work. The heavy oil would produce too great resistance by its viscosity to be suitable for light work, and the watch oil would be unable to sustain the pressure in heavy work.

As I have already stated, lubricants are tested to determine their value by placing them as nearly as possible under the conditions of actual work. This is done in machines designed for this purpose. A considerable number have been invented, although but two or three are in use.

One of the oldest is this, fig. 5 and 6 (showing it), of McNaught. It consist of two disks. The upper one is loose; the lower one lower one turns, the friction between them carries the upper one with it, but its motion is restrained by a pin, *F*, which comes in contact with another pin, f_1 in the end of the arm of a T-lever, *G' H I J*, which is pivoted at *H*. A movable weight, *K*, slides on the arm *G H*, on which is a scale to note its position. A counterweight, *I*, is attached to the opposite end of the lever, so as to afford the means of a more delicate adjustment. It is evident that the resistance due to the friction between the two disks may in this way be very accurately measured by the position of the weight *K*.]

This is not a very complete instrument, as you see.

In Napier's machine, fig. 7, there is a wheel, *B*, of which the smooth, wide rim is pressed by a brake-block, *A*, which is forced against it with any desired amount of pressure by the action of weighted levers *D* and *F*. The effort of the wheel to carry the block around is resisted by another weighted lever, *C*, and by it the friction is measured.

Another machine, fig. 8, which has been well known abroad for many years and has recently been introduced to some extent in the United States, is that of Messrs. Ingham & Stapfer. It consists of a shaft running in two bearings and carrying a third journal between them. This latter has adjustable bearings, which are set up to any desired pressure by weighted levers.

A thermometer in the top brass enables the heating of the bearing to be observed. In this machine the friction cannot be measured; but the durability of an oil and its effectiveness in keeping a bearing cool can be observed. The machine has been extensively used in Europe, where Messrs. Bailey & Co., of Salford, have been building it many years. It has been made in the United States by Mr. Asncroft, of Boston, and is here known by his name. A somewhat similar, but much larger, machine has been used at the Brooklyn Navy Yard ten years or more, and an elaborate investigation was made there by Messrs. King, Stivers and Price, of the United States Navy Engineer Corps.

Among other forms of machine should be mentioned that of the Lake Shore & Michigan Southern Railway,* at Cleveland, which consists of a railroad axle driven at standard speed and cate the rise in temperature, and the shaft *B B* has a worm gear, *N*, which works into suitable gear wheels, *O* and *O'*, which form a revolution counter, the index finger *P* indicating on a graduated face, which is not shown in the engraving, the number of revolutions made by the machine. From this description it will therefore be seen, that this machine determines the co-efficient of friction of the oil and the rise in temperature due to a certain amount of work done, which is determined by the pressure on the plates and the number of revolutions made in a given time.]

This is the first of my illustrations in which all the required conditions can be introduced. Here the oil may be introduced in standard quantity, under the proposed pressure, and the machine can be driven at the required speed; while the thermometer and the spring balance show the temperature, and that more important figure, the amount of friction. The machine might be so proportioned as to give the co-efficient of friction, although it might be a nice matter, perhaps, to obtain its exact measure.

An immense amount of work has been done in the Mechanical Laboratory of the Stevens Institute of Technology, in testing lubricating as well as other materials. In this work, one and sometimes two machines, such as are shown here (fig. 12 and 13), have been in constant use for many months.

Although I may claim to be the inventor of this machine, which is, I think, the first in which *all* the conditions of actual practice can be introduced and from which all the desired measures can be obtained, I must credit a student of the class of 1873 of the Stevens Institute of Technology (Mr. J. A. Henderson, now of the United States Navy Engineers) with the production of this graceful and thoroughly satisfactory design. These machines are all made in the workshops of the Institute and have been supplied to mills, shops and railroad companies abroad as well as at home. They have done work for all classes of dealers in and customers of oil, as well as the more strictly scientific work of our mechanical laboratory. In this machine we try to test the lubricant at the pressure under which it is proposed that the journal on which it is to be used shall run, and at the speed proposed for the journals on which it is to be used.

* Prof. Thurston uses the formula: $p = \frac{60,000}{v}$ for marine and stationary steam engines, and Rankine gives for locomotives $p = \frac{44,800}{60\ v + 20}$.—Johnson's Cyclopedia; Art. Friction.

* Illustrated in the *Railroad Gazette* of June 15, 1877.

The machine is fitted for a wide range of pressures, as is seen on the index-plate *M N*, on the pendulum *H H*, where the large figures represent the total pressures on the journal, and those opposite the corresponding pressures per square inch.

The speed of the machine, when the belt is upon the largest pully of the cone *C*, should be that which will give the least speed of rubbing at the surface of the testing journal, which is to be usually adopted.

The figures on the arc *P P'*, traversed by the pointer *O*, attached to the pendulum, are such that the quotient of the reading on the arc *P P'*, by the total pressure read from the front of the pendulum at *M N*, gives the "co-efficient of friction," *i. e.*, the proportion of that pressure which measures the resistance due to friction.

A printed table is furnished with each machine, giving these co-efficients for a wide range of pressures and arc-readings.

To determine the lubricating quality, we remove the pendulum *H H* from testing journal *G G'*, adjust the machine to run at the desired pressure, by turning the screw-head *K*, projecting from the lower end of the pendulum, until the index *M*, above, shows the right pressure, and adjust it to run at the required speed by placing the belt on the right pulley, *C*.

We then throw out the bearings by means of the two little cams on the head of the pendulum *H*, in the small machine, or by setting down the brass nut immediately under the head in the large machine; we next carefully slide the pendulum upon the testing-journal *G G'*, and see that no scratching of journal or brasses takes place.

Then we oil the journal through the oil-cups or the oil holes, set the machine in motion, running it a moment until the oil is well distributed over the journal.

Next stop the machine; loosen the nut or the cams which confine the spring, and, when it is fairly in contact and bearing on the lower brass with full pressure, turn the brass nut or the cams fairly out of contact, so that the spring may not be jammed by their shaking back while working. Now, start the machine again and run until the behavior of the oil is determined, keeping up a free feed throughout the experiment.

At intervals of one or more minutes, as may prove most satisfactory, observe and record the temperature given by the thermometer *Q Q'*, and the reading indicated on the arc *P'*, of the machine, by the pointer *O*. When both readings have ceased to vary, the experiment may be terminated.

Remove the pendulum, first relieving the pressure of the spring, and clean the journal and brasses with exceedingly great care from every sign of grease; and be especially careful not to have a particle of lint on either surface, or any grease in the oil-cup or oil-passages.

A comparison of the results thus obtained with several oils will show their relative values as reducers of friction.

In each case we record in tables like these blanks, which are sent with the machine:

1. The pressure and speed of rubbing at each trial.
2. The observed temperature.
3. The readings on the arc of the machine.
4. The calculated co-efficients of friction.

We enter at the end of the trial the average and the minimum co-efficients, and the total distance *rubbed over* by the bearing surfaces.

To determine the liability of the oil to gum, we allow the machine to stand with the journal wet with oil, but with none feeding through the bearing, for 12 or 24 hours or more, as may be found necessary. Then start up and run a few moments until the reading on the arc *P P'*, having fallen to a minimum, begins to rise again; then stop *at once*. Compare the minimum co-efficients thus obtained from the several oils to be examined; that which gives the smallest figure will be least liable to gum during the period of time given to the test.

To determine durability, we proceed as in determining the friction, except that the lubricant should not be continuously supplied, but should be fed to the bearing, a small and definite portion at a time—say a drop for each two inches length of journal. Extreme care should be taken that each portion actually reaches the journal and is not lost, either in the oil-hole or by being wiped off the journal, and that the portions applied are *exactly* equal.

When the friction, as shown by the pointer *O*, has passed a minimum and begins to rise, the machine should be carefully watched, and should be stopped either at the *instant* that the friction has reached double the minimum, or when the thermometer indicates 212° F.; or else another portion of the lubricant should be then applied to the journal.

This operation should be repeated until the duration of each trial becomes nearly the same; an average may then be taken either of the time, of the number of revolutions, or of the distance rubbed over by the bearing, which average will measure the durability of that lubricant.

Next, we carefully clean the testing-journal and proceed as before with the next oil to be tested.

In making comparisons we always test the standard, as well as the competing oils, on the same journal and under *precisely* the same conditions.

An approximate value, by which to compare the oils, can be calculated, based on the assumption that they will have a money-value proportionate to their durability and to the *inverse* ratio of the value of the co-efficient of friction. Thus: suppose two oils to run, the one 10 minutes and the other 5, under a pressure of 100 lbs. per square inch, and both at the same speed, and suppose them to give on test for friction the co-efficients 0.10 and 0.06 respectively.

Their relative values might be taken at $\frac{6}{10}=1$ and $\frac{5}{6}=0.833$. If the first is worth one dollar, the second should be worth 83⅓ cents.

In many cases, however, about the same quantity would be applied by the oiler, whatever oil might be used, and their values to the consumer would be in the inverse proportion of the values of their co-efficients of friction, *i. e.*, as 6 in the above case is to 10, thus making the value of the second $1.66⅔, and proving that it would be better to use the latter at anything less than this price than the first at one dollar. Oils actually take their market values more in accordance with the latter than with the former method of valuation.

We are compelled to be exceedingly careful of the testing-journal. A scratch will alter the conditions, sometimes, to a measureable degree. For nice work, the size of drops is very carefully preserved constant. It is sometimes weighed on a chemists' balance. For rough work, a dropper, such as is used for medicine, with careful handling, will do very well. I have had very good work done by dropping the oil from a No. 8 wire, filed smoothly to rather a blunt point. Dipping it in the oil, the first drops, when held vertical, are variable, but, after a half minute or so, they become uniform. We use the drop that falls after the expiration of ¾ minute. This wire (showing it) yields drops of sperm, at that instant, weighing eight milligrammes. We are always careful to see that the testing journal has a little end-play in its bearings and keep it moving, during the test, to keep the oil distributed.

Many of our railroad companies, as well as other consumers of oil, are now regularly testing in this or some less thorough manner, and some of them are saving immense sums by this simple plan. The most complete system is that of the Pennsylvania Railroad Company, as practiced by Dr. Dudley in the laboratory at Altoona, where all the materials used on the road, properly subject to such examination, are tested, including their iron and steel, etc., as well as their lubricants.

In the Mechanical Laboratory of the Stevens Institute of Technology all results are entered in a set of record-books, where they are permanently preserved for the use of the Institute and for the accommodation of those having the work done. The results of test are furnished to the latter on printed blanks like these (showing them), which are similar to the pages of the record-books.

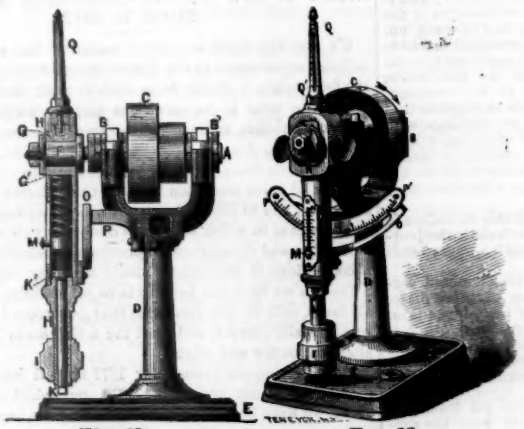

Fig. 13.

Fig. 12.

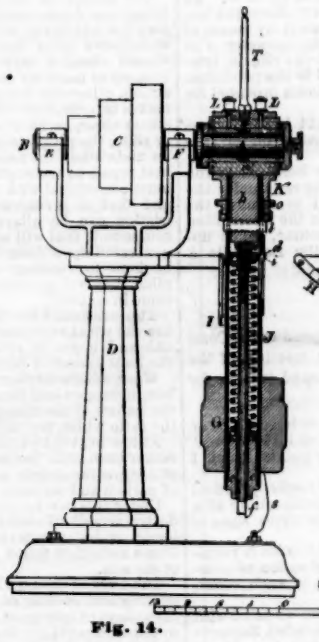

Fig. 14.

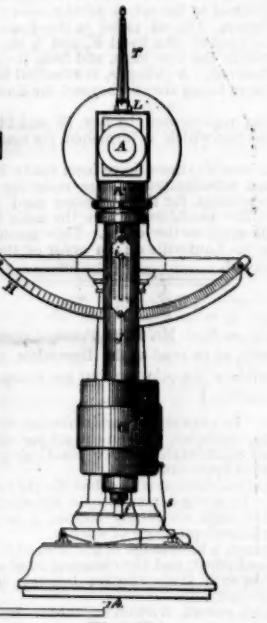

Fig. 15.

These books contain, already, a vast amount of exceedingly valuable information, from which I can give you a few facts:

You will see that the friction is modified by all differences in the material of the journal and its bearings, as well as by pressure, speed of rubbing, temperature and freedom and uniformity of lubrication, and can therefore readily appreciate the necessity of testing the lubricant under the actual conditions proposed in its use. Thus we have for *intermittent feed:*

CO-EFFICIENTS OF FRICTION ON CAST-IRON JOURNALS:

Velocity, 750 feet per minute; Temperature, 70° F.

Name of Oil.	Pressure in pounds per square inch.			
	8	16	32	48
Summer sperm	0.1330	0.1083	0.0833	0.1050
" whale	0.1500	0.0916	0.0874	0.0777
Winter lard	0.1666	0.1166	0.1000	0.0750
Neatsfoot	0.1500	0.1000	0.0916	0.1055
Cotton seed	0.1577	0.1250	0.1083	0.0694
Olive	0.1333	0.1000	0.1000	0.0555
Palm	0.1666	0.1250	0.0584	0.0666
Rapeseed	0.1333	0.1250	0.0838	0.0722
Elaine	0.2000	0.1500	0.0833	0.1111
Peanut	0.1500	0.1333	0.0792	0.0550
Menhaden	0.1660	0.1000	0.9170	0.1000
Cod	0.1500	0.1250	0.6666	0.0661
Heavy mineral	0.1333	0.1416	0.0791	0.0944
Mineral lubricating*	0.1500	0.1500	0.1250	0.1444
Crude "	0.1100	0.1000	0.1500	0.1500
Paraffine*	0.2000	0.1333	0.1126	0.2222

*These oils are of uncertain composition.

Tested on a fine steel journal, with free lubrication, the figures become but a fraction of those just given.

Sperm, lard and West Virginia oil, thus tested, give:

CO-EFFICIENT OF FRICTION ON FINE STEEL JOURNALS.

Name.	Pressures; pounds per square inch.						
	4.	10.	25.	150.	200.	250.	275.
Sperm	0.12	0.8	0.041	0.0090	0.0096	0.0086	0.0091
Lard	....	....	0.056	0.0136	0.0127	0.0110	0 0090
West Virginia	....	....	.....	0 0120	0.0095	0.0081	0.0100

Testing a large number of the oils of commerce for durability on a cast-iron journal, we at one time used 32 milligrammes at each application and noted the time required to run the journal dry, with this result:

OILS OF COMMERCE, AVERAGE.

Pressure per square inch.	Running Time.			Rise of Temp.	Ave. co-efficient, *f*.
	Ave.	Min.	Max.		
8 lbs.	82	17	411	167° F.	0.20
16 "	29	9	97	212	0.16
32 "	10	2	19	228	0 12
48 "	8	1	13	228	0.10

Several well-known oils ran thus—the speed was 750 ft. per minute.

ENDURANCE, ETC., OF LUBRICANTS ON CAST IRON.*

	Running Time.	Rise of Temp.	Co-eff.
Summer sperm	8	111 min.	230° F.	0.13
" "	16	29	225	0.10
" "	48	9	195	0.08
Lard	8	165	270	0.13
"	16	33	215	0.11
"	48	7	205	0.10
Olive	8	83	170	0.13
"	16	41	245	0.10
"	48	14	240	0.06
Cotton Seed	8	107	185	0.16
" "	16	45	275	0.12
" "	48	12	310	0.07
Cod	8	40	200	0.15
"	16	14	175	0.12
"	48	9	220	0.07
Crude mineral (?)	8	129	105	0.10
" "	16	97	285	0.10
" "	48	5	270	0.10

Comparing a mixture of plumbago and grease with sperm oil, the former was found to have a lower co-efficient, to heat up less rapidly and to endure several times as long. It was also found that plumbago in very fine flakes was better than in an impalpable powder—a result which was to me unexpected†.

*See *Polytechnic Review*, March 3, 1877.
†See *American Machinist*, November, 1873, p. 3.

Testing for durability, on a small steel journal, sperm and lard oils gave these results:

ENDURANCE OF SPERM AND LARD OILS.

Durability of one 8-milligramme drop: feet run

Pressure per sq. in.	100	200	250	275
Sperm	7204	7685	7675	7521
Lard	6797	7139	7090	7008

Others of the commercial oils found in the market and largely purchased by consumers who have no means of testing them endure but for a very small fraction of the time and the distance traveled with sperm and lard, and I have never yet found an oil which equals sperm in this quality.

Tests made on the machine of the Lake Shore & Michigan Southern Railway and reported to the Master Mechanics' Association are stated, however, to give the following results*:

Fifty drops of each were used at one application, and the machine driven at a speed corresponding to 35 miles an hour until the temperature shown by the thermometer rose from 60° to 200° F. The total number of revolutions was as follows:

ENDURANCE OF OILS—L. S. & M. S. R. R.

Castor	12,946 rev.	West Va.	7,915 rev.
Paraffine	11,685 "	Sperm	7 912 "
Mecca (black)	9,982 "	Tallow	7,794 "
Neatsfoot	8,277 "	Lard	7,317 "

Another useful series of tests was made some time ago by Mr. A. H. Van Clive, and published in the *Scientific American* of Dec. 9, 1871.

The tests made in the Mechanical Laboratory of the Stevens Institute of Technology, and of which the results have been given, have been made on the smallest testing machine here exhibited.

This larger one (showing it, see figures 14 and 15) is not yet finished, but is a copy of one built at the Institute for the Pennsylvania Railroad Laboratory at Altoona.

The journal is of their standard car-axle size, 3¼ inches diameter and 7 inches long.

The speed is intended to be adjusted to speeds varying from that of a 26-inch engine-truck wheel at 60 miles an hour down to that of a 42-inch wheel running 15 miles an hour. The pressures are adjustable from a few pounds total pressure up to 400 pounds per square inch, or a load of nearly 10,000 pounds on the journal.

[Fig. 14 is a side elevation of the larger machine, with the journal and pendulum in section, and fig. 15 a front elevation. It consists of a shaft, *A B*, which is driven by a cone pulley, *C*, the whole mounted on a cast-iron

*National Car-Builder.

stand, *D*, terminating in a forked end at the top, with two bearings, *E* and F, in which the shaft runs. The shaft projects beyond the journal *F*, and the projecting part *A* is provided with a sleeve or bushing, *m m*, the outside of which forms a journal on which the tests of oil are made. A pendulum, *A G*, is suspended from this journal with suitable bearings, *a a*, which work on he journal *m m*. A heavy weight, *G*, is attached to the lower end of the pendulum. It is evident that the friction on the journal *m m* will have a tendency to move the pendulum in the direction of the revolution of the shaft and that the greater the friction on the journal the farther will the pendulum swing. A scale or dial, *H I*, is attached to the stand, and the distance the pendulum swings may be read off on this scale, which thus indicates the co-efficient of friction of the lubricant on the journal. In order to get any desired pressure of the bearings on the journal, the pendulum is constructed as follows: A wrought-iron pipe, *J*, which is represented in fig. 14 by solid black shading, is screwed into the head *K*, which embraces the journal and holds the bearings *a a* in their place. In this pipe a loose piece, *b*, is fitted, which bears against the under journal-bearing *a'*. Into the lower end of the pipe a piece, *c c*, is screwed with a hole drilled in the centre through which a rod, *f*, passes, the upper end of which is screwed into a cap, *d*. Between this cap and the lower piece, *c c*, a spiral spring, shown in section in fig. 14 is placed.

The upper end of the rod has a cap, *e*, in which it turns and which bears against the piece *b*, which in turn bears against the bearing *a'*. If the rod is turned with a wrench applied to the square head at *f*, it is obvious that the cap *d* will be either drawn down on the spiral spring, which will thus be compressed, or it will be moved upward, and the spring will thus be released, according to the direction in which the rod is turned. If the spring is compressed its lower end will bear against the under cap and on the piece *c c*, by which the pressure will be transmitted to the pipe *J*, and thence to the head *K*, and from that on the upper journal-bearing *a*; while at the same time the upper end of the spring bears against the cap *d*, which, being screwed on the rod *f*, transmits its pressure upward to the cap *e*, and from that to the loose piece *b*, and from that to the under journal-bearing *a'*. It will thus be seen that any desired pressure within the limits of the elasticity of the spiral spring may be brought upon the journal and bearings by turning the rod *f*. The piece *b* has a key, *l*, which passes through it and the pipe *J*. This key bears against a nut, *o*, which is screwed on the pipe, its object being to provide a ready means of relieving the journal of pressure by simply turning the nut *o* when it is desired to do so. An index, *i*, is attached to the spiral spring so as to show the position of the latter. The oil is fed to the journal by means of oil-cups, *L L* on top of the head *K*, and a thermometer *T* is attached between the two cups, and from it the rise in temperature is observed. A string, *s*, is attached to the pendulum to prevent it from being thrown beyond the limits provided for it.

The machine represented by figs. 13 and 14 is the largest size, and is the one which is furnished for testing oil for railroads.]

Some slight modifications have been made here, as in the cone-pulley and substituting a large relieving nut under the head of the pendulum for the two cones used to remove the load in the smaller machine; but in the main the description of the one will apply to the other. This machine, when finished, is to go to Louisville on an order of the Louisville & Nashville Railroad.

Lubricating Oils.

[Communication from Mr. F. S. Pease, directed to the Committee on Rooms, to be read at the December meeting of the Master Car Builders' Association, but not received in time for the January meeting.]

GENTLEMEN: In answer to your invitation to be present or send some data, statistics, etc., on the subject of lubrication, I enclose for your consideration a few practical points which I hope will be most opportune.

The subject of lubrication is one that should receive practical consideration. So much depends upon the simple oiling of a journal that, although seemingly simple, it involves some of the most complicated questions of science.

In the first place, a knowledge of the laws of *friction* is requisite, of cause and effect, and the chemical combustion of compounds, together with their relative bearing to each other, under different conditions.

The laws which govern friction are not to be violated with impunity, and the more rapidly they are apprehended, the more speedily railroad men and manufacturers will be relieved from the most serious responsibilities which now press upon them.

Whenever friction is overcome, heat is produced, and the heat produced is the force expended in overcoming the friction.

The heat (an oscillation of ultimate particles) is simply the primitive force in another form, and if we wish to avoid this conversion, we must abolish the friction.

It is the object of every railroad engineer to urge his train bodily from one place to another.

He wishes to apply the force of his steam, or of his journal, which gives tension to the steam for this particular purpose.

It is not his interest to allow any portion of that force to be converted into another form of force which would not further the attainment of his object.

He does not want his axles heated, and hence he avoids as much as possible expending his power in heating them.

In fact, he has obtained his force from heat, and it is not his object to reconvert the force thus obtained into its primitive form, for every degree of temperature generated by friction of his axles, a definite amount would be withdrawn from the urging force of his engine. The only object in lubricating our journals and axles is that mechanical energy may be converted into heat, and that when so converted it cannot still exist as mechanical energy, but that for every degree of heat developed a strict and proportionate equivalent of the locomotive force of the engine disappears. The conditions of friction on railroad axles are unequal, and subject to the rolling friction, lateral friction and friction of collision, each of which, being so much leakage and loss of power, depends not only upon the properties of the bodies acting, but upon the force spent in producing it.

To lubricate under these conditions and with atmospheric changes, requires something more than guess-work.

A complete knowledge of facts and the laws that govern them is necessary.

Before entering into the subject further, we may at this point introduce a very interesting class of natural substances that are to play an important part.

OILS.

The general division of these greasy substances is that of fat and fixed. They are, however, entirely dissimilar, both in properties and composition; indeed, except in the one common property, they are entirely allied to each other. Oils are found abundantly in the vegetable, animal and mineral kingdoms. In the former they occur in various parts of the plant, principally in the cellular structures, in the fleshy pulp surrounding the seeds, and, very rarely, the roots. They are contained in that part of the seed which gives birth to the colytedons, and not in the plumular or radicle. In the olive tree only the oil is contained in the fleshy integuments of the fruit. In animals, fats are contained chiefly in the cellular membrane, and for the most part immediately beneath the skin. In the whale species, the bony cavity of the head is the depository of the secreted spermaceti. The mineral, a composition of vegetable organisms, generally marine plants, reduced to a pulp and mingled with argillaceous mud before deposition, is pumped from the earth. The combined action of heat upon vegetable and animal oils has a very remarkable effect. At about 500° they assume a darker color and evolve acid together with offensive vapors, and when further heated, eliminate carbonic acid and carbide of hydrogen gases, accompanied by a peculiarly irritating substance termed acroleum, also margaric and sibacic acids, and liquid carbides of hydrogen. In hydro-carbon oils the tendency of heat is evaporation at a low temperature of the condensed vapors. The point at which these alterations take place has been improperly said to be the boiling point, the phenomenon of apparent ebullition arising from the escape of the gases produced by the decomposition of the oil.

Oils must be adapted for the use for which they are intended and the amount of friction to be overcome. An oil to meet all the conditions must be made with some little knowledge of its component parts, and to meet all the variable conditions of friction, in whatever shape presented. An oil that lubricates a slide or eccentric may be entirely decomposed under steam heat or heavy pressure. Another, applied in a constant stream, proves a dead failure when left to feed by capillary attraction. Another, applied to the heavy rolling friction, is ill adapted to lighter and more speedy bearings. While another, that runs a spindle at ten thousand, may lack tenacity enough to separate the friction surfaces of an axle.

It seems to be the general impression that a different oil must be used for each and every different point of friction—one for cars, coaches, engines, cylinders; that the cheapest and poorest oil is good enough for cars, a better oil for coaches than for engines, and that tallow of any kind is good enough for cylinders, and so on. All of this is radically, practically and scientifically wrong, and this, together with poor iron, poor waste and poor brasses, is the *key* to *hot boxes*, and the general wholesale destruction of the railway rolling stock of the country. That an oil *can* be compounded and adapted to run *all kinds* of machines, and in illustration is the fact that the machinery at the late Centennial Exhibition, *Machinery Hall, Government Building, Agricultural Hall, Shoe and Leather Building, Saw Mill*, and all the *annexes*, over *two* and *one-half miles* of *shafting* (*main* and counter) and over *ten thousand bearings*, were run for six months, with our improved *engine oil*, without even a *warm* bearing or a *single failure*.

Oils should be thick for heavy bearings that they may resist being forced out, and thin for light bearings that their viscidity may not add to the resistance. Oils to *lubricate under all circumstances* must have tenacity as well as cooling properties, should stand a high heat without change, should not be volatile oil or made by distillation, should not show any acid reaction, otherwise heating and cutting will be produced; and it makes no difference whether the heat is immediate, as in the steam chest, or slow and long continued, as on the crank pin or slide, the ultimate effect is the same. All practical mechanics understand the necessity of keeping their machinery in the best repair to accomplish timely results; that the lubrication must correspond with the amount of friction to be overcome, and that it is contrary to progressive science to suppose that friction can be allayed by oiling journals or bearings with compounds that will not stand the amount of heat that will be generated upon them by motion; also that machinery cannot be kept in running order when chemical compounds are applied that will crystalize and oxydize the iron with which they come in contact.

The continued heating and cooling of journals on railroads has the effect to crystalize the iron and either destroy the journals and boxes or reduce their strength to such a degree that the least excess of force breaks them.

When substances are composed of only three elements, carbon, hydrogen and oxygen, or mainly made up of these three, the nature of the change on the application of heat depends on the ratio which the oxygen and hydrogen bear to each other.

At low heat the oxygen prefers to unite with the hydrogen rather than with the carbon. At high temperature the affinity of oxygen for carbon is most powerful, and more of the oxides of carbon and carbonic oxides are found.

Under this can be classed every hydro-carbon oil made by destructive distillation; for under the action of heat the carbonic oxides penetrate, the heated metal is decomposed. Cause and effect follow each other like the rising and setting of the sun.

The lives of thousands of people are daily endangered by the heating and cooling of the journals on our railroads, and in these days of increased speed and competition, it is a matter of so much importance that all questions of inconvenience and embarrassment to the public will receive practical consideration.

LUBRICATION.

The cause of lubrication in oils is on account of the cohesion of its molecules.

When hard and smooth surfaces cannot interlock they therefore slide over each other with the greatest facility and between two plain surfaces, one in motion, they roll along under the burden, rectifying irregularities of bearings, changing sliding friction to rolling friction, and notably reducing the power required to move the given load, producing a slippery surface.

The question as to the best oil for railroad purposes will never be fully decided, and for the reason that individual opinion will not allow it.

The custom of purchasing agents to make tests and to purchase oils according to their tests, find that our ideas have become general, although the few cents saved per gallon may be lost ten times over on the other accounts, which are not taken into consideration.

To become familiar with the nature of oils a thorough knowledge of science and machinery is necessary, and added to these our untiring industry in the line of observation, experiments and analysis must be followed and practical tests made.

Not upon the laboratory machine, but the oiling of *cars* and *engines* under the *practical conditions of friction*.

It is not our object to discuss the value of testing machines, but would quote the opinion of our leading railway journal upon the subject:

"It should, however, be kept in mind that the value of oil is due to its effectiveness in oiling cars and engines, and not testing machines.

"The purpose aimed at in applying oil is to run the cars with the least friction and trouble from heating, and not to buy an article which will come up to certain arbitrary tests. Of course the object of the tests is to determine before using the lubricant whether it is of good quality; but what we want to impress here is the lesson taught in the homely saying that the 'proof of the pudding is in the eating.'

"Now in the case of lubricants, there is no method of testing them so effective as actual use, and no report of their quality will have nearly the value that a careful record of the cost of oiling, the number of hot boxes, and other items of information would have if they were constantly kept and tabulated.

"Testing oils with instruments expressly designed for that purpose is undoubtedly very useful, but the only machines or instruments which should be implicitly trusted are the cars themselves."

And I would say in conclusion, that the same amount of time spent in speculation and microscopic analysis would be of more practical value to the student.

It is interesting to witness the results of investigation, that are now and then published to the world, with all the gravity of experts upon the subject of lubrication.

Suppose that every one would inform you that pure bleached winter sperm oil did not possess qualities which would render its general use advisable.

Suppose that you were informed that paraffine oil would run longer and do more work than Government standard sperm, and be cheaper than common, cheap black oil, where on common coal cars it *has been shown*, your common sense would at once prompt you to answer that sperm is the best *natural* lubricator known. Yet such assertions have been made, and are believed.

It is a noticeable fact that all roads endorsing cheap hydro-carbon oils are at the present time running more or less hot. A trip over the lines will convince the most skeptical.

The remedy for hot boxes is simple: *use oil adapted for the work intended*, and purchase of reliable manufacturers only.

Modesty forbids my presenting to your notice what I have accomplished and can do in regard to railroad oils, and I will only say, that my success is not due to guess work but indefatigable experiments based upon scientific principles and tests.

The point is not what the oil *costs* per gallon, but what are the *final results accomplished* by its use.

Gentlemen, look at your rolling stock, your repair account, and then consider the first cost of the oil.

The life and future of our railroads depend on strict practical economy, and practical and scientific knowledge based upon *experience* not to be ignored.

Cheap oil, cheap material, cheap brains, at the *expense of repair account, power* and *human life* do not constitute economy.

A thorough knowledge of the material to be purchased, that it *is adapted* to the purpose or work to be accomplished or requirements of the road is necessary, and not experiments to accomplish results that can never be, and with material entirely inadequate and antagonistic to each other, and final results.

If economy consists in using a cheap oil for lubricating, why does it not hold good in cheap axles, boxes, waste, cheap road-bed, cheap rails, cheap engines, coal, etc.?

Nor can railroads afford the expense of using a cheap oil, that requires attention at every wood-pile, at the expense of rolling stock, power and repair account.

In fact, there is no economy in the use of a cheap article for railroad use in any department, and the *harder* the times, the *better* should be the article used, and *save* in the *length* of time that it will last, obviating the detailed and continued expense a tending the use and application of a cheap and poor material.

Yours respectfully, F. S. PEASE.

BUFFALO, Dec. 19, 1877.

Record of New Railroad Construction in the United States in 1877.

We give this week our usual record of the mileage of new railroad constructed in the United States during the past year. We follow this so closely from week to week that the result, so far as the total is concerned, is already anticipated by our readers; but this summary gives an abstract of the new work in tracklaying done on each road for the whole year, with the total for each State and each group of States.

Especial pains are taken to make this record correct, definite and clear, and to this end extended inquiries have been made in every case in which there was doubt, as well as a careful examination and comparison of previous statements. The result is corrections of statements made in many cases heretofore. Although we have not been able to get definite information in all cases, still we are confident that our record as it stands is substantially correct, and that the additions to be made hereafter will be few and slight.

Before giving the record for 1877 we will here present the corrections of our record for 1876, published Jan. 19, 1877, which we have been able to make during the past year:

The *Cincinnati & Westwood Railroad*, 5 miles of 3 ft. gauge, in the suburbs of Cincinnati was wholly omitted from that record.

The *Rock Island & Mercer County Railroad*, there reported 13 miles long, seems to have been completed for its whole length of 22 miles in 1876.

On the *Chicago, Clinton & Western* 10 miles of track were laid and not noted in our record.

What was called there the extension of the *Tehama Branch* of the *California Pacific*, the legal name of which is the *Northern Railway*, extending from Woodland north to Williams, is but 39 miles long—6 miles shorter than was there reported.

This makes an error of *eighteen miles* in the total mileage reported a year ago in our record for 1876, which should have been 2,460 miles.

This record is intended to include all new road on which track was laid during the year, and it is mileage of *road*, and not mileage of *track* that is counted. No account is taken of second tracks and sidings, whether on new or old roads, but the new road on which track is laid is counted *as soon as the track is laid*, and a considerable mileage chronicled below is not yet open for business.

Any errors or omissions discovered hereafter in this list will be promptly corrected as soon as they become known to us, and we will be grateful to any one who will call our attention to such errors at any time, whether they regard the length reported, the time of its construction (it is extremely difficult to get accurate information on this point), or the termini and direction of the completed sections. We endeavor to describe each section of new road in such a way that the reader, with a good map, can mark it down for himself in its proper place. Termini of new railroads, however, are frequently places which cannot be found on any map, so that this is not always possible.

Some comments on the work of the year will be found on the editorial pages.

NEW HAMPSHIRE.

Brown Lumber Company.—This corporation completed a railroad from a junction with the Boston, Concord & Montreal at Whitefield, N. H., eastward 12 miles to Jefferson Meadows; It was intended for hauling logs and lumber, but is being prepared for passenger traffic, and there is talk of extending it 13 miles further to the Grand Trunk at Gorham.

Manchester & Keene.—The first track is laid from Greenfield, N. H., the terminus of the Peterboro Railroad, westward to Hancock, 6 miles.

VERMONT.

Burlington & Lamoille.—Completed from Burlington, Vt.,

northeastward 35 miles to the Portland & Ogdensburg at Cambridge Junction.

Portland & Ogdensburg.—The Vermont Division was completed early in the year by the construction of a section from Johnson, Vt., west by north 36 miles to a point four miles east of Swanton, making the road 121 miles long across Vermont, and in connection with the Maine and New Hampshire section 235 miles long, from Portland, Me., north by west to Lake Champlain.

MASSACHUSETTS.

Billerica & Bedford.—Completed from the Middlesex Central at Bedford, Mass., northward 8¾ miles to North Billerica. Gauge, *two* feet.

Boston, Winthrop & Point Shirley.—Completed from its junction with the Boston, Revere Beach & Lynn at Winthrop Junction, a few miles from Boston, eastward to Winthrop, Mass., 2 miles. Gauge, 3 ft.

Rhode Island & Massachusetts.—Of the 14 miles of this new road (described under Rhode Island) 6¾ are in Massachusetts.

RHODE ISLAND.

Moshassuck Valley.—Completed early in the year, from a junction with the Providence & Worcester at Woodlawn, R. I., to Scott's Pond, 2 miles.

Rhode Island & Massachusetts.—Completed from the New York & New England Railroad at Franklin, Mass., southward 14 miles to the Providence & Worcester at Valley Falls. It serves a number of manufacturing villages. The part of the road in Rhode Island is 7¾ miles long.

CONNECTICUT.

Colchester.—Completed from the village of Colchester, Conn., to Turnerville, 3½ miles, where is a connection with the Boston & New York Air Line, which works the new road as a branch.

NEW YORK.

New York & Manhattan Beach.—Under the name of *New York, Bay Ridge & Jamaica* three miles of this road were constructed in 1876, from New York Bay at Bay Ridge, just south of Brooklyn, eastward to a junction with the Brooklyn, Bath & Coney Island Railroad. In 1877 this line was extended eastward to Coney Island, 5 miles, and a branch was constructed from a point four miles east of Bay Ridge northward 5 miles to East New York. It is entirely devoted to carrying passengers to the seaside resort on Coney Island. Gauge, 3 ft.

Olean, Bradford & Warren.—Just before the close of the year the entire New York section of this road was completed, from Olean, the crossing of the Erie and the Buffalo, New York & Philadelphia roads, southwestward 12½ miles to the State line, whence about 4½ miles remained to be built to connect with the Pennsylvania section east of Bradford. The road serves a new oil region. Gauge, 3 ft.

Rochester & Slate Line.—At the beginning of 1877 this road was completed from Rochester, N. Y., southwestward 35 miles to Pearl Creek. It was opened for business to Warsaw, 44 miles, Aug. 1, and to Gainesville, 54 miles, Oct. 8, and the track has since been extended and constructed from other railroad junctions until at the close of the year 103 of the 108 miles of track of the whole line from Rochester to Salamanca were laid, making 68 miles laid in the year.

Syracuse, Geneva & Corning.—This road was wholly completed in the year from a junction with the New York Central & Hudson River at Geneva, N. Y., southward 56¾ miles to Corning, where it connects with the Fall Brook Coal Company's roads and the Erie. It is chiefly intended to carry Fall Brook coal to the New York Central, and the latter company has some interest in it.

Utica, Ithaca & Elmira.—Track was laid near the end of the year from De Ruyter, N. Y., northward 5 miles to Shedd's Corners, being the beginning of an extension which will give the road an outlet to the New York Central at Canastota, of which ten miles remains to be completed.

NEW JERSEY.

Freehold & New York.—Completed from Freehold, N. J., northward 14 miles to New York Bay at Keyport.

Montclair & Greenwood Lake.—Extended from Cooper, N. J., north by east 3 miles to Avington, near the New York line, making the road 44¼ miles long.

Paulinskill Valley.—Completed from a junction with the Morris & Essex Division of the Delaware, Lackawanna & Western at Delaware station northeastward up the Paulinskill valley to Blairstown, N. J., 10¼ miles.

Philadelphia & Atlantic City.—Completed from Camden, N. J., opposite Philadelphia, southeast 54 miles to Atlantic City. It was opened in July. It is intended chiefly to carry passengers to and from the seaside resort at Atlantic City. Gauge 3 ft. 6 in.

PENNSYLVANIA.

Allegheny, Kennerdell & Clintonville.—Completed from a junction with the Allegheny Valley at Scrubgrass, Pa., up Scrubgrass Creek 2½ miles to Kennerdell. It was originally intended to extend it 12 miles further, but here is no present prospect of it.

Columbia & Port Deposit.—This road was completed early in the year by the laying of track from Conowingo, Pa., up the east bank of the Susquehanna 4 miles to Peach Bottom, making it 39 miles long from a junction with Columbia Branch of the Pennsylvania Railroad at Columbia, Pa., southeastward 39 miles to the Philadelphia & Baltimore Central at Port Deposit, Md. It is worked by the Pennsylvania Railroad Company.

East Berlin Branch.—The road extends from the Hanover Junction, Hanover & Gettysburg at Red Hill to East Berlin, Pa., seven miles, of which 4 were completed in 1877.

Emlenton, Shippenville & Clarion.—This road, last year called the *Emlenton & Shippenville* and then 8 miles long, was extended in 1877 eastward to Clarion, Pa., 21¾ miles, making t 29¾ miles long from the connection with the Allegheny Valley road at Emlenton. It serves the Clarion oil region. Gauge, 3 ft.

Foxburg, St. Petersburg & Clarion.—Completed from a junction with the Allegheny Valley road at Foxburg, Pa., eastward 7 miles to Turkey City. It serves a district in the Clarion oil region. Gauge, 3 ft.

Lewisburg, Centre & Spruce Creek.—Extended from Laurelton, Pa., eastward 24 miles to Spring Mills, making the whole road 44 miles long from its junction with the Philadelphia & Erie at Montandon. It is worked by the Pennsylvania Railroad.

Ligonier Valley.—Completed from a junction with the main line of the Pennsylvania Railroad at Latrobe, Pa. (41 miles east of Pittsburgh), southeast 10 miles to Ligonier. It is of 3 ft. gauge, with a third rail for the standard gauge for a few miles.

Olean, Bradford & Warren.—Track was laid near the close of the year from a junction with the Buffalo, Bradford & Pittsburgh Division of the Erie Railway at Bradford, Pa., just south of the New York line, eastward 5 miles to Tarport, leaving about 4½ miles to be built to reach the New York section, which also was completed in 1877. Gauge, 3 ft.

Pittsburgh, Castle Shannon & Washington.—This road is an extension of the *Pittsburgh & Castle Shannon*, which has been in operation a few years from Pittsburgh southward seven miles to Castle Shannon, Pa. Last year the company above named completed an extension south by west eight miles, and grading was done for a further extension of six miles, to Right's, and of a branch of four miles to Washington. The gauge of the old road was 3 ft. 4 in.; that of the new is 3 ft.

Pittsburgh, Virginia & Charleston.—Extended from Monongahela City, Pa., southward up the Monongahela River 23 miles to Brownsville, making the road 54 miles long from Pittsburgh southward.

Sharpsville.—This company completed an extension of two miles from Bethel, Pa., to Carbon Coal Co.'s junction, making the road about seven miles long from its junction with the Mahoning Division of the Atlantic & Great Western southeastward. It is built to serve coal mines and blast furnaces in Northwestern Pennsylvania.

Uniontown & West Virginia.—Completed from the southern terminus of the Southwest Pennsylvania Railroad at Uniontown, Pa., southward 4½ miles to Olyphant Furnace. It is controlled and worked by the Pennsylvania Railroad Company.

Waynesburg & Washington.—The entire track was laid last year, from a junction with the Chartiers Branch of the Pittsburgh, Cincinnati & St. Louis at Washington, Pa., southward 27 miles to Waynesburg. Gauge, 3 ft.

VIRGINIA.

Chesapeake & Ohio.—This company built during the year a branch 1.81 miles long from its main line up Morris Creek in West Virginia. It was built to reach some coal mines.

Milton & Sutherlin.—The first track was laid near the end of the year from the junction with the Richmond & Danville at Sutherlin, Va., southwestward 5 miles. Gauge, 3 ft.

Potomac, Fredericksburg & Piedmont.—Extended westward 10 miles to Orange Court House, Va., making it 38 miles long from Fredericksburg westward. The road is built by the Royal Land Company. Gauge, 3 ft.

NORTH CAROLINA.

Jamesville & Washington.—This road was extended from the old terminus 10 miles south of Jamesville, N. C., southward 15 miles to Washington, completing a line 25 miles long, from the Roanoke River south.

Raleigh & Augusta Air Line.—Extended southwest 12 miles to a junction with the Carolina Central at Hamlet, N. C., making the road 98 miles long from Raleigh southwest.

SOUTH CAROLINA.

Ashley River.—Completed from a junction with the Northeastern Railroad of South Carolina, seven miles from Charleston, south by west 3¾ miles to Bee's Ferry, whence it is continued to the *Savannah & Charleston* Railroad by the

Ashley River Branch of the last-named road, which is five miles long, from Bee's Ferry south by west to the junction at John's Island Ferry, 5 miles. The two together make a cut-off by which cars pass from one road to the other without entering Charleston. Both are of 5-ft. gauge.

Cheraw & Chester.—The first track was laid, from Chester, S. C., east 5 miles. Gauge, 3 ft.

Spartanburg & Asheville.—Completed from Spartanburg, S. C., northwest 27 miles to Tryon Mountain, with 30 miles of road-bed graded beyond. Gauge, 5 ft.

Pensacola & Mobile Railroad & Manufacturing Co.—This company, which is engaged in manufacturing lumber, leased the use of 15 miles of the Pensacola Railroad from Pensacola northward to Cantonment, Fla.; constructed a branch 4 miles long from Cantonment westward to Muscogee Mills, and an extension 1 mile long from Pensacola eastward to Muscogee Wharf. Gauge, 5 ft.

ALABAMA.

Eureka Iron Company.—This company completed a branch from the South & North Alabama at Standiford, Ala., to its ore beds, 1¼ miles. Gauge, 5 ft.

LOUISIANA.

New Orleans, Jackson & Northern.—An extension, 2 miles long, was built in New Orleans from the depot to the levee at the river landings. Gauge, 5 ft.

TEXAS.

Corpus Christi, San Diego & Rio Grande.—The company began the year with five miles of road from Corpus Christi westward. This was extended during the year 20 miles further west to Banquette, and 17 miles more are under way. Gauge, 3 ft.

Dallas & Wichita.—The track has been laid from Dallas, Texas, the crossing of the Texas & Pacific and the Houston & Texas Central, northwest 17 miles, and the grading is completed 18 miles further.

Denison & Southeastern.—The first track was laid late in the year from Denison, Tex., where the Missouri, Kansas & Texas crosses Red River, southeast 8 miles to Choctaw River.

East & West Texas.—Completed from Houston, Tex., east by north 35 miles. Gauge, 3 ft.

East Line & Red River.—Extended from Hickory Hill, Texas, northwestward 10 miles to Daingerfield, making the road 30 miles long from Jefferson northwestward.

Galveston, Brazos & Colorado.—During the year this road was extended 5 miles to a point 15 miles west of Galveston, Texas. Gauge, 3 ft.

Galveston, Harrisburg & San Antonio.—This road was completed early in the year by the laying of track from the Cibolo River west 10 miles to San Antonio, Tex., making the road 214 miles long, from Harrisburg westward.

Henderson & Overton.—Completed in April from a junction with the International & Great Northern at Overton, Texas, southeastward 16 miles to Henderson.

Houston & Texas Central.—The *Waco Branch* was extended early in the year from Waco, Tex., northwest 11 miles to White Rock, making the branch 56 miles long from its junction with the main line at Bremond.

Longview & Sabine Valley.—Completed from the Texas & Pacific at Longview south 4 miles. It serves some saw mills. Gauge, 3 ft. The road-bed is ready, and iron bought for eleven miles more.

Sabine Pass & Northwestern.—This road was completed from a junction with the Texas & Pacific at Lawrence, Tex., south 12 miles to Kaufmann. Gauge, 3 ft.

Texas Western.—Extended from Wimberly, Tex., westward 11 miles to Pattison, making the road 41 miles long from Houston westward. Gauge, 3 ft.

Tyler Tap.—Completed from a junction with the Texas & Pacific at Big Sandy, Tex., south by west 20 miles to Tyler.

TENNESSEE.

Duck River Valley.—Extended from Fountain Creek, Tenn., east by south 14 miles to Lewisburg, Tenn., making the road 20 miles long from its junction with the Nashville & Decatur at Columbia. Gauge, 3 ft.

Nashville, Chattanooga & St. Louis.—The *Jasper Branch* was extended from Jasper, Tenn., north by east 7¾ miles up the Sequatchie valley to the coal mines of the Southern States Coal, Iron & Land Co., making the branch 19¾ miles long from the junction with the main line at Bridgeport, Ala. Gauge, 5 ft.

KENTUCKY.

Cincinnati Southern.—This road was completed between the Ohio River (Ludlow) and Somerset, Ky., 158 miles, by the filling in of three little gaps during 1877, one of 7 miles from the Kentucky River at High Bridge southward, and one of 4 miles from the southern terminus to a point two miles beyond Somerset; later in the year 1.3 miles of track were laid from Ludlow across the Ohio River bridge to Liberty street in Cincinnati, making 12.3 miles of new road in 1877. Gauge, 5 ft.

Covington, Flemingsburg & Pound Gap.—Track was laid from Johnson, on the Maysville Division of the Kentucky Central, west 6 miles to Flemingsburg. Gauge, 3 ft.

Southwestern of Kentucky.—Completed from a junction with the Cincinnati Southern near Burgin, Ky., west by north 10 miles to Harrodsburg. Gauge, 5 ft.

WEST VIRGINIA.

Pittsburgh, Wheeling & Kentucky.—The first track was laid on this line, from a junction with the Pittsburgh, Cincinnati & St. Louis near Holliday's Cove, W. Va., southward 23 miles to the edge of the city of Wheeling, along the West Virginia side of the Ohio.

OHIO.

Bellcair & St. Clairsville.—Early in the year 6¼ miles of track were laid from the Baltimore & Ohio at Quincy, O., 4½ miles west of Bellaire, northwestward to St. Clairsville, 6¼ miles.

Bellcair & Southwestern.—The first track was laid on this road near the close of the year from Bellaire, O., south 6 miles to Wegee Mill, on the Ohio. The road is located thence southward to Woodsfield, Monroe County, about 38 miles further. Gauge, 3 ft.

Cincinnati & Eastern.—Extended from Batavia, O., eastward 33 miles to Winchester, making the road 48 miles long from its junction with the Little Miami at Plainville. Gauge, 3 feet.

Cincinnati & Portsmouth.—Completed from Cincinnati eastward 11 miles to Mount Carmel. Gauge, 3 ft.

College Hill.—This Cincinnati suburban road was extended from the old terminus at College Hill to Mt. Pleasant, 3 miles, making the whole road 6½ miles long from its junction with the Cincinnati, Hamilton & Dayton in Cincinnati. Gauge, 3 ft.

Columbus & Hocking Valley.—This company has completed 5 miles of the *Monday Creek Branch* which leaves the main line near Nelsonville, O., extends southeastward two miles down the Hocking River, and northward three miles up Monday Creek, and is under construction for seven miles further up the creek northwestward to Grafton; also the *Snow Fork Branch*, from a junction with this Monday Creek Branch at Bessemer, four miles from Nelsonville, northeastward 4 miles to Orbiston (Ogden Furnace), making 9 miles of new road completed. These branches accommodate the new blast furnaces in this region, of which there are now eight completed and three or four more nearly ready to go into blast.

Dayton & Southeastern.—At the end of 1876 the track of this road was laid, with the exception of one mile, on the 47½ miles from Dayton east by south to Washington, O. Last year this section was completed and an extension made from Washington eastward 21 miles to Musselman's, making the road 68½ miles long from Dayton southeastward, and leaving 46 miles to be completed in the same direction to Wellston. Gauge, 3 ft.

Lake Erie, Alliance & Wheeling.—Extended from Palmyra, O., northward 10 miles to the Atlantic & Great Western at Braceville, making the road 24 miles long from Alliance north. Gauge, 3 ft.

Painesville, Canton & Bridgeport.—The first track was laid

near the end of the year, from Chagrin Falls, O., south by west to the Mahoning Division of the Atlantic & Great Western at Solon, 5 miles. Gauge, 3 ft.

Paulding & Cecil.—This road has been completed from Paulding, O., north by west 7 miles to the Wabash Railway at Cecil.

Scioto Valley.—This road was extended from Chillicothe, O., southward 48 miles to the Ohio River at Portsmouth, completing the line, which is 98 miles long, from Columbus southward.

Springfield, Jackson & Pomeroy.—At the close of 1876 there were two miles of this road completed, from the Portsmouth Branch of the Marietta & Cincinnati at Jackson, O., west. Last year this line was extended 23 miles west by north to Waverly, on the Scioto Valley road; and on the northern end 13 miles were built, from Springfield east by south to South Charleston Gauge, 3 ft.

Toledo & Delphos.—Completed from a junction with the Pittsburgh, Fort Wayne & Chicago at Delphos, O., north by east 15 miles to Dupont. A good deal of work has been done south of Dupont toward Celina, to which (26 miles) it is intended to extend the road this year.

Waynesville, Port William & Jeffersonville.—This road has been completed from a junction with the Dayton & Southeastern at Allentown, O., west by south 11 miles to Port William. Gauge, 3 ft.

Wheeling & Lake Erie.—A section of this road was completed from the Lake Shore & Michigan Southern at Norwalk north to Huron, O., 12⅛ miles, and also 1 mile from New London northward. Gauge, 3 ft.

MICHIGAN.

Glencoe, Pinconning & Lake Shore.—Completed from the west shore of Saginaw Bay, Mich., westward 14 miles to Glencoe. It is intended chiefly for lumber traffic.

Lake George & Muskegon River.—This is a private railroad, built to carry logs from the woods to the Muskegon River, and is 7 miles long.

Menominee River.—This road was completed from its connection with the Lake Superior line of the Chicago & Northwestern near Spaulding, Mich., about 22 miles south of Escanaba, and west of Green Bay, westward 26 miles past the Breen and Brietung mines to the Quinneseck iron mine. It is constructed to carry iron ore from these mines, chiefly to Escanaba for shipment, and is worked by or in connection with the Chicago & Northwestern Company.

Toledo & South Haven.—This is built in connection with the old *Paw Paw Railroad*, from Lawton on the Michigan Central north 4 miles to Paw Paw, Mich. The gauge was changed and on extension built from Paw Paw west 9 miles to Lawrence. Gauge, 3 ft.

INDIANA.

Indianapolis & Springfield.—The first track was laid from the Logansport, Crawsfordville & Southwestern at Rockville, Ind., west 4 miles to Coloma.

Union Railway, Transfer & Stock Yards.—This company has completed what is known as the "Belt Railroad" around Indianapolis, to facilitate transfers of cars from one road to another, without passing through the city. It is 12 miles long, more than half with double track, and has a great length of sidings.

ILLINOIS.

Chicago, Burlington & Quincy.—The *Keithsburg Branch*, recently purchased with the St. Louis, Rock Island & Chicago road, was extended from Keithsburg north three miles to New Boston

Grayville & Mattoon.—This road was extended from Newton, Ill., north by west 30 miles to a point two miles north of Prairie City, and within 16 miles of Mattoon, making the road 50 miles long from its junction with the Ohio & Mississippi at Olney northward. Some contract has been made to unite it with the Decatur, Mattoon & Southern road, now is operation between Decatur and Mattoon.

WISCONSIN.

Chicago, Milwaukee & St. Paul.—Late in the year the *Necedah Branch* was completed from the La Crosse Division at Lisbon, Wis, northward 12 miles to Necedah. It is intended to accommodate the large lumber trade of Necedah.

Fond du Lac, Amboy & Peoria.—The first track was laid in 1877, and the road completed from Fond du Lac, Wis., southward 30 miles to the Northern Division of the Chicago, Milwaukee & St. Paul at Iron Ridge. It is of 3-ft. gauge.

Wisconsin Central.—This road was completed June 4 by the laying of track between Butternut Creek and Chippewa River, Wis., 12 miles. This makes a line owned by the company from Menasha to Ashland, on Lake Superior, 250 miles, with a branch 71 miles long from Stevens Point south to Portage, while it works 128 miles more of leased line.

MINNESOTA.

Minneapolis & St. Louis.—This road, at the beginning of the year, was in operation from Minneapolis southward 27 miles to junction with the St. Paul & Sioux City road. In 1877 it was extended southward 91 miles through Albert Lea to the Iowa line. It leases the 13 miles south of Albert Lea to the Burlington, Cedar Rapids & Northern, in connection with which latter road it forms a line 367 miles long, from Minneapolis to Burlington.

Minnesota Midland.—This road was completed from the Mississippi River at Wabasha, Minn., westward up the Zumbro valley 29 miles to Millville. Gauge, 3 ft.

St. Paul & Pacific.—In October this company completed the construction of a line 32 miles long from the old terminus of its main line on the Red River at Breckenridge, Minn., northward to Barnes, where it unites with the St. Vincent Extension, of which the new road forms the southern end. This completes a line 121 miles long from Breckenridge north to Fisher's Landing, and gives the St. Vincent Extension an outlet over the St. Paul & Pacific, which before depended on the Northern Pacific.

Western of Minnesota.—This road, formerly the *Brainerd Branch* of the *St. Paul & Pacific*, was completed during the year by the laying of track from Watab, Minn., northward 50 miles to a point 4 miles south of its junction with the Northern Pacific at Brainerd, completing a line 136 miles long from St. Paul to Brainerd. It is controlled by the Northern Pacific and gives it a line to St. Paul as well as Duluth.

Worthington & Sioux Falls.—This road was built in 1876 from a junction with the Sioux City & St. Paul road at Worthington, Minn., westward 34 miles to Luverne. Last year it was further extended from Luverne to Beaver Falls, 8 miles, leaving 16 miles to be built to reach Sioux Falls. The road is intended largely to make available lands granted to the Sioux City & St. Paul and St. Paul & Sioux City roads.

IOWA.

Burlington, Cedar Rapids & Northern.—Late in the year the company extended its *Main Line* from Plymouth northwest 6 miles to the Central Iowa at Shell Rock, and leased 10 miles of the Central Iowa from Shell Rock to Northwood, built 4 miles from Northwood to the Minnesota line, and leased the southern 13 miles of the *Minneapolis & St. Louis* from Northwood northwestward to Albert Lea, Minn., so that it now works a main line 251 miles long from Burlington northwestward to Albert Lea, forming in connection with the Minneapolis & St. Louis a new and direct line 367 miles long from Burlington to Minneapolis. The 13 miles of the Minneapolis & St. Louis from the State Line to Albert Lea were built with a guarantee of the Burlington, Cedar Rapids & Northern on the bonds issued on that section.

The same company earlier in the year extended its *Pacific Division* from Traer, Iowa, west by north 23¼ miles to Holland, Grundy County, making this branch 48 miles long from its junction with the main line at Vinton.

Chicago, Dubuque & Minnesota.—Late in the year the *Turkey River Branch* was extended from Elkport, Iowa, west by north 25 miles to Wadena, making the whole branch 40 miles long from the junction with the main line at Turkey River.

Des Moines & Minnesota.—Late in the year this 3 ft. gauge road was extended from its junction with the Chicago & Northwestern at Ames, Iowa, northward 10 miles to Story City, Iowa, making the road 47 miles long, from Des Moines northward.

Mople River.—This railroad was completed from a junction with the Chicago & Northwestern near Carroll, Iowa (95 miles northeast of Council Bluffs), northwestward, westward and southwestward to Mapleton, near the Missouri River, a distance of 59 miles.

Waukon & Mississippi.—Completed from a junction with the Chicago, Dubuque & Minnesota at Adams, Iowa, northwestward 23 miles up Paint Creek to Waukon, 23 miles. Gauge, 3 ft.

MISSOURI.

Joplin.—Extended from the terminus at the end of 1876 southeastward 16 miles to Joplin, Mo., making the whole road 36 miles long from its junction with the Missouri River, Fort Scott & Gulf at Girard, Kan. It serves lead and coal mines in Missouri.

KANSAS.

Central Branch, Union Pacific.—Extended from Greenleaf, Kan., 113 miles west of Atchison, west by south 28 miles to Clyde, with progress made for 15 miles further, to Concordia.

Florence, Eldorado & Walnut Valley.—Completed from a junction with the Atchison, Topeka & Santa Fe near Florence, Kan., 172 miles from Kansas City, southward 29½ miles to Eldorado. It is expected to receive a considerable traffic in Texas cattle driven across Indian Territory. The Atchison, Topeka & Santa Fe works it as a branch.

Kansas Central.—This 3 ft. gauge road was extended from its old terminus at Holton, Kan., westward 24 miles to Onaga, making the road 80 miles long from Leavenworth westward.

Kansas City, Burlington & Santa Fe.—In 1876 the first part of this road was built, from a junction with the Leavenworth, Lawrence & Galveston near Ottawa, southwest 13 miles to Williamsburg. Near the end of last year it was extended westward 5 miles further. The road-bed is ready 18 miles further, on the way to Burlington.

NEBRASKA.

Nebraska.—Extended from Seward, Neb., westward 27 miles to Troy, making the line 132 miles long from Brownville. The road was formerly called the *Midland Pacific.*

Omaha & Republican Valley.—Extended from Wahoo, Neb., westward 42 miles to David City, making the road 61 miles long from its junction at Valley Station with the Union Pacific.

WYOMING.

Colorado Central.—Of the new extension to the Union Pacific about five miles are in Wyoming.

COLORADO.

Colorado Central.—This road was extended from Longmont, Colorado, northward 70 miles to a junction with the Union Pacific at Hazard, Wyoming, six miles west of Cheyenne, giving the Union Pacific, which controls it, a line to Denver, 126 miles long from the junction. About five miles of the road are in Wyoming. The *Georgetown Branch* (which is of 3 ft. gauge) was extended from Floyd Hill to Georgetown Col., 21 miles.

Denver & Rio Grande.—The *San Juan Branch* was extended from La Veta, Col., westward over the mountains 29 miles to Garland, making this branch 50 miles long from Cuchara, and giving the company 302 miles of road, 220 of it in one line, which is the longest narrow-gauge road in the world.

UTAH.

Utah Western.—Extended from Lake Point, Utah, southward 20 miles to a tunnel in the direction of Stockton, making the road 41 miles long from Salt Lake City. Gauge, 3 ft.

CALIFORNIA.

Northern.—This company in 1876 built an extension of the *California Pacific* from Woodland northward 39 miles (reported a year ago as 45 miles) to Williams. In 1877 it was engaged on what will form a southern outlet of the California Pacific to Oakland, but which will be most important as the western section of a new loop line over which *Central Pacific* traffic will reach San Francisco. The track laid in 1877 is from Oakland, the terminus of the Central Pacific, northward and eastward near the shore of San Francisco and San Pablo bays to Martinez, on the Straits of Carquinez, 28 miles, where it will be met by the eastern section of the loop, the *San Pablo & Tulare Railroad.* The Northern Railroad will be further extended from Benicia, across the Straits of Carquinez, northward to the California Pacific near Fairfield, about 15 miles.

North Pacific Coast.—Extended from Moscow, Cal., to Duncan's Mill, 1 mile, making the line 73⅛ miles long from San Francisco Bay at Saucelito. Gauge, 3 ft.

San Pablo & Tulare.—This company is constructing the eastern section of what will form a new loop line of the *Central Pacific* east of San Francisco Bay. Its road is completed from a junction with the Central Pacific at Bantas, 75 miles east of San Francisco Bay at Oakland, northwestward 32 miles to Antioch, near the mouth of the Sacramento and San Joaquin in Suisun Bay. About 30 miles remains to complete the road along Suisun Bay and the Straits of Carquinez to Martinez.

Southern Pacific.—The main line was extended from Indian Wells east by south 120 miles to Yuma, Arizona, completing a line 720 miles long from San Francisco to the mouth of the Colorado River, part of which is owned, while the whole is worked, by the *Central Pacific* Company. The branch known as the *Los Angelos & San Diego Railroad* was extended near the close of the year from Anaheim southward 7 miles to Santa Ana, making the line from Los Angelos in the direction of San Diego 33⅛ miles long.

South Pacific Coast.—In 1876 this line was built from Newark, Cal. (formerly Dumbarton Point), southeastward 15 miles to Santa Clara. In 1877 it was extended in both directions. On the south from Santa Clara through San Jose to Los Gatos 18 miles, and on the north from Newark northward 20 miles to San Francisco Bay at Alameda, making the whole extension 38 miles, and the total length of road now in operation from Alameda southward 53 miles. The section from Newark to Alameda was built by the *Bay & Coast Company*, and leased to the South Pacific Coast. A further extension of 22 miles south of Los Gatos is begun.

Vaca Valley.—Extended from Winter's, Cal., northward 13 miles to Madison.

WASHINGTON TERRITORY.

Northern Pacific.—The *Puyallup Branch* was completed from its junction with the Pacific Division at New Tacoma, Wash. T., to the Puyallup coal mines, 31 miles.

Seattle & Walla Walla.—Completed from Seattle, Wash. T., on Puget Sound, to the Seattle Coal Company's mines at Newcastle, 21⅛ miles. The first 15 were completed early in the year, the rest in the fall. Gauge, 3 ft.

SUMMARY.

NEW HAMPSHIRE.		
Brown Lumber Co.	12	
Manchester & Keene	6	
		18
VERMONT.		
Burlington & Lamoille	35	
Portland & Ogdensburg	36	
		71
MASSACHUSETTS.		
Billerica & Bedford (2 ft.)	8½	
Boston, Winthrop & Point Shirley (3 ft.)	2	
Rhode Island & Massachusetts	6½	
		17½
RHODE ISLAND.		
Moshassuck Valley	2	
Rhode Island & Massachusetts	7¾	
		9¾
CONNECTICUT.		
Colchester	3½	
		3½
NEW YORK.		
New York & Manhattan Beach (3 ft.)	10	
Olean, Bradford & Warren (3 ft.)	12½	
Rochester & State Line	68	
Syracuse, Geneva & Corning	56¼	
Utica, Ithaca & Elmira	5	
		151¾
NEW JERSEY.		
Freehold & New York	14	
Montclair & Greenwood Lake	3	
Paulinskill Valley	10½	
Philadelphia & Atlantic City (3½ ft.)	64	
		81½
PENNSYLVANIA.		
Allegheny, Kennerdel & Clintonville	2½	
Columbia & Port Deposit	4	
East Berlin Branch	4	
Emlenton, Shippenville & Clarion (3 ft.)	21¾	
Foxburg, St. Petersburg & Clarion (3 ft.)	7	
Lewisburg, Centre & Spruce Creek	24	
Ligonier Valley (3 ft.)	10	
Olean, Bradford & Warren (3 ft.)	5	
Pittsburgh, Castle Shannon & Washington (3 ft.)	8	
Pittsburgh, Virginia & Charleston	23	
Sharpsville	2	
Uniontown & West Virginia	4½	
Waynesburg & Washington (3 ft.)	27	
		142¾
VIRGINIA.		
Chesapeake & Ohio—Morris Creek Branch	1¾	
Milton & Sutherlin (3 ft.)	5	
Potomac, Fredericksburg & Piedmont (3 ft.)	10	
		16¾
NORTH CAROLINA.		
Jamesville & Washington	15	
Raleigh & Augusta Air Line	12	
		27
SOUTH CAROLINA.		
Ashley River (5 ft.)	3¾	
Cheraw & Chester (3 ft.)	5	
Savannah & Charleston—Ashley River Branch (5 ft.)	5	
Spartanburg & Asheville (5 ft.)	27	
		40¾
FLORIDA.		
Pensacola & Mobile Railroad & Manufacturing Co. (5 ft.)	5	
		5
ALABAMA.		
Eureka Iron Company (5 ft.)	1½	
		1½
LOUISIANA.		
New Orleans, Jackson & Northern (5 ft.)	2	
		2
TEXAS.		
Corpus Christi, San Diego & Rio Grande (3 ft.)	20	
Dallas & Wichita	17	
Denison & Southwestern	8	
East & West Texas (3 ft.)	35	
East Line & Red River	10	
Galveston, Brazos & Colorado (3 ft.)	5	
Galveston, Harrisburg & San Antonio	10	

TEXAS (CONTINUED.)	
Henderson & Overton	16
Houston & Texas Central—Waco Branch	1
Longview & Sabine Valley (3 ft.)	4
Sabine Pass & Northwestern (3 ft.)	12
Texas Western (3 ft.)	11
Tyler Tap	20
	— 179
TENNESSEE.	
Duck River Valley (3 ft.)	14
Nashville, Chattanooga & St. Louis—Jasper Branch (5 ft.)	7½
	— 21½
KENTUCKY.	
Cincinnati Southern (5 ft.)	12½
Covington, Flemingsburg & Pound Gap (3 ft.)	6
Southwestern Kentucky (5 ft.)	10
	— 28½
WEST VIRGINIA.	
Pittsburgh, Wheeling & Kentucky	23
	— 23
OHIO.	
Bellaire & St. Clairsville (3 ft.)	6½
Bellaire & Southwestern (3 ft.)	6
Cincinnati & Eastern (3 ft.)	33
Cincinnati & Portmouth (3 ft.)	11
College Hill (3 ft.)	3
Columbus & Hocking Valley—	
Monday Creek Branch	5
Snow Fork Branch	4
Dayton & Southeastern (3 ft.)	22
Lake Erie, Alliance & Wheeling (3 ft.)	10
Painesville, Canton & Bridgeport (3 ft.)	5
Paulding & Cecil	7
Scioto Valley	48
Springfield, Jackson & Pomeroy (3 ft.)	36
Toledo & Delphos	15
Waynesville, Port William & Jeffersonville (3 ft.)	1
Wheeling & Lake Erie (3 ft.)	13½
	— 236
MICHIGAN.	
Glencoe, Pinconning & Lake Shore	14
Lake George & Muskegon River	7
Menominee River	26
Toledo & South Haven (3 ft.)	9
	— 56
INDIANA.	
Indianapolis & Springfield	4
Union Railway, Transfer & Stock Yards	12
	— 16
ILLINOIS.	
Chicago, Burlington & Quincy—Keithsburg Branch	3
Grayville & Mattoon	30
	— 33
WISCONSIN.	
Chicago, Milwaukee & St. Paul—Necedah Branch	12
Fond du Lac, Amboy & Peoria (3 ft.)	30
Wisconsin Central	12
	— 54
MINNESOTA.	
Minneapolis & St Louis	91
Minnesota Midland (3 ft.)	29
St. Paul & Pacific	32
Western, of Minnesota	50
Worthington & Sioux Falls	8
	— 2 0
IOWA.	
Burlington, Cedar Rapids & Northern—	
Main Line extension	10
Pacific Division extension	23½
Chicago, Dubuque & Minnesota—Turkey River Branch	25
Des Moines & Minnesota (3 ft.)	10
Maple River	59
Waukon & Mississippi (3 ft.)	23
	— 150½
MISSOURI.	
Joplin	16
	— 16
KANSAS.	
Central Branch, Union Pacific	28
Florence, Eldorado & Walnut Valley	29½
Kansas Central (3 ft.)	24
Kansas City, Burlington & Santa Fe	5
	— 86½
NEBRASKA.	
Nebraska	27
Omaha & Republican Valley	42
	— 69
WYOMING.	
Colorado Central	5
	— 5
COLORADO.	
Colorado Central—	
Main Line	65
Georgetown Branch (3 ft.)	21
Denver & Rio Grande—San Juan Branch (3 ft.)	29
	— 115
UTAH.	
Utah Western (3 ft.)	20
	— 20
CALIFORNIA.	
Northern Railway	28
North Pacific Coast (3 ft.)	1
San Pablo & Tulare	32
Southern Pacific—	
Main Line Extension	120
San Diego Branch	7
South Pacific Coast (3 ft.)	38
Vaca Valley	13
	— 239
WASHINGTON TERRITORY.	
Northern Pacific—Puyallup Branch	31
Seattle & Walla Walla (3 ft.)	21½
	— 52½
Total mileage laid in United States in 1877	2,199
" " " " " " 1876	2,460
" " " " " " 1875	1,561
" " " " " " 1874	2,025
" " " " " " 1873	3,883
" " " " " " 1872	7,340
" " " in past six years	19,452
" " completed at end of 1877	79,663
Estimated population in 1877	45,800,000
Population per mile of railroad	575

Slipping of Locomotive Wheels.

A correspondent of the *English Mechanic* communicates the following facts in relation to this interesting subject:

There are two kinds of "slipping" generally known to engineers as "slipping proper" and "imperceptible slipping." The first of these is, of course, when the driving-wheels fly round at undue speed for want of adhesion, or from the slippery state of the rails. But the second or "imperceptible slipping" is, as its name applies, imperceptible to any person riding upon the engine or watching it. The fact is that in every locomotive the driving-wheels make more revolutions in running a given distance than is theoretically necessary, and this excess of revolutions varies under different circumstances and with different classes of engines from one to fifty revolutions per mile. It must not be supposed that M. Rabeuf has made any discovery, as "imperceptible slipping" was discovered as long ago as 1832, by George Stephenson, upon the Bagworth incline of the Leicester & Swannington Railway

In last volume I mentioned trials which were made by George Stephenson upon this railway to determine what has since been known as "tractive force." While so engaged it was found that a new engine named "Samson" was frequently short of steam, and for some weeks the cause could not be discovered. Stephenson and his manager maintained that the boiler was in proper proportion, and Stephenson gave his opinion that either the engine was making too many revolutions or else that steam was blowing through the valves. The number of revolutions per mile was then counted, when it was found that the engine made about 40 more than it should have done, whereupon two heavy iron castings, weighing half a ton each, were bolted on each side of the frame over the driving axle. The engine was again tried, when it was found that the "imperceptible slipping" had been reduced from 40 to 8 or 9 revolutions, and that the boiler was able to supply the engine with plenty of steam, and the engine continued to run with these weights until 1848, when it was broken up, as the cylinders were only 14 in. diameter and 18 in. stroke, and not powerful enough for the work then required. A great number of experiments were also made with another engine named "Comet," which had four coupled wheels of 5 feet diameter, and cylinders 12 × 16. This engine was built in 1832, and drew the first train at the opening of the Leicester & Swannington Railway, July 17, 1832.

When in 1833 the subject of single and coupled engines was under discussion, this engine had the side rods taken off and ran as a single engine for six months, but the "imperceptible slipping" increased so considerably that the blast pipe had to be reduced in order to obtain the necessary amount of steam, the result, of course, being that there was an increase of back pressure, and also a large increased consumption of fuel, and at the end of the six months' working the side rods were again put on. The engine was also, in 1833, fitted with four sand-boxes and pipes, but for a considerable time the dust of granite chippings from the Groby quarries was used instead of sand. This engine, the Comet, continued to work till 1848, on the Swannington Railway. After this it was used upon several colliery branches until 1852. About two years later it was purchased again at "old iron price," by Stephenson & Co., as a relic.

In 1868 a long series of trials were made by the late Mr. Kirtley, Locomotive Superintendent, upon the Wirksworth, Ripley and Lincoln branches of the Midland Railway, as to the subject of "imperceptible slipping." I may mention that I was present by invitation at several of these trials, in which I took a great interest, although I am not a Midland "official." The first engine tried was No. 134 (now 134A), built by Stephenson & Co., 1852, having cylinders 16×22, and a single pair of driving wheels 6 ft. 8 in. diameter. An indicator was fixed upon the right-hand side of the engine showing the actual number of revolutions made, and it was found that with a train of 10 carriages, at 50 miles an hour, the engine made 290 revolutions per mile, instead of 252, or an excess of 38 revolutions, caused by imperceptible slipping. A coupled engine, No. 190, built by Beyer, Peacock & Co., 1867, having four coupled wheels of 6 ft. 2 in. diameter, and cylinders 16½×24, was then tried with the 10 carriages at the same speed. This engine was found to make 17 extra revolutions per mile.

The side rods were then taken off, when it was found that the extra revolutions had increased from 17 to 43. On another occasion I was present when similar trials were made upon the Great Northern Railway, and it was found that one of their 7 ft. single engines, running 60 miles an hour, with ten coaches, down the incline from Potter's Bar to Wood Green, was making 281 revolutions per mile instead of 240. At another time, an 8 ft. engine was tried at the same speed down the same incline, with 12 coaches, and made 242 revolutions instead of 210. It has been shown that it is no use for an engine to have a high tractive force unless it has also the necessary adhesive weight.

In another letter the same correspondent says:

The Comet was the first engine that ever ran south of Manchester. It was built at Newcastle-upon-Tyne in the beginning of the year 1832, from the design of George Stephenson, and it was conveyed to the West Bridge Station, Leicester, in pieces, by canal, and was then put together in the old engine shed, which was pulled down and rebuilt about 12 or 13 years ago. The following are the leading dimensions of the Comet: The engine ran on four wheels, coupled, and had an outside frame only; the cylinders were also placed inside.

	ft.	in.
Diameter of cylinders	0	12
Length of stroke	0	16
Diameter of all four wheels	5	0
Diameter of boiler	3	0
Length of boiler	6	6
Number of tubes	97	
Diameter of tubes	0	1⅝
		sq. ft.
Heating surface of tubes		302.9
Heating surface of fire box		37.3
Total		340.2
	tons.	cwt.
Weight of engine in working order	9	9½
Weight of tender in working order	4	0
Total	13	9½

The working pressure was originally 50 lbs. per square inch, which was afterwards increased to 60, 70, and ultimately to 80 lbs. This engine was the first that was ever fitted with a steam whistle, in consequence of its running into a horse and cart on a level crossing near to Thornton. The idea of a steam whistle was suggested to Mr. Stephenson in March, 1833, by Mr. Ashlen Bagster, the manager of the Swannington Railway, and in the next month the first steam-whistle was fitted to this engine. It was made by a musical instrument-maker, and was, in fact, a steam trumpet. In November, 1842, the Comet was thoroughly repaired and fitted with the link motion, which had a few months previously been invented by Mr. Howe. It has been erroneously stated that the first steam whistle was not invented till 1835, but the facts I have given disprove this.

THE SCRAP HEAP.

Railroad Manufactures.

The Railway Speed Recorder Co. held its annual meeting in Kent, O., Jan. 7, when Dr. W. W. Wythe, A. L. Dunbar, J. T. Blair, J. B. Miller and E. A. Parsons were chosen directors. The board chose A. L. Dunbar President; E. A. Parsons, Secretary and Treasurer; J. B. Miller, Superintendent.

The Ogden Iron Works, at Ogden, Utah, have been transferred to a new corporation, known as the Equitable Coal & Iron Co., which has a capital of $100,000. The new company expects to start the blast furnace soon.

Messrs. Heller & Brightly, the well known instrument manufacturers, of No. 33 North Seventh street, Philadelphia, are now filling one of the largest orders for surveying instruments ever given in this country. The order is from Columbia College, New York, for use in its School of Mines, and is for 38 instruments in all, transits, levels and plane tables, the amount of the contract being $8,600. The order is considered by the manufacturers as a high endorsement of the excellence of their work.

Besides the contracts already noted, J. B. & J. M. Cornell and A. & R. Whitney, of New York, have a contract for about 6,000 tons of the superstructure for the New York Elevated Railroad.

Kellogg & Maurice, of Athens, Pa., have also a contract for 2,000 tons for the same road.

The Bessemer steel works of the Albany & Rensselaer Iron & Steel Co. started up Jan. 2.

Besides the order for the Madeira & Mamore Railway, the Philadelphia & Reading Coal & Iron Co.'s rail mill, at Reading, Pa., is making a lot of light rails for the Toledo, Ann Arbor & Northern road, and has also an order from the South Pacific Coast Company.

J. G. Brill & Co., of Philadelphia, Pa., have several orders for narrow-gauge passenger and freight cars to go to Cuba and Mexico.

Osgood Bradley & Co., at Worcester, Mass., are building 18 iron freight cars for the National Tube Works Co. The cars are to go on the Providence & Worcester road, which has already some of the same kind in use.

The Cleveland City Forge & Iron Co. has elected the following officers for the ensuing year: President, R. H. Harman; Vice-President and Manager, L. M. Coe; Secretary and Treasurer, G. Fely.

The North Jersey Iron Co. now has one furnace, at Port Oram, N. J., running on spiegel-eisen. Several grades have been made, ranging from 10 to 24 per cent. manganese. The furnace is 60 feet high by 15 feet bosh, and makes about 140 tons per week. Foreign ores have been chiefly used, but some native ores are to be tried.

The *Iron Age* makes the following report of the condition of the blast furnaces of the United States on Jan. 1:

	1878. In blast.	1878. Out of blast.	1878. Total.	1877. In blast.	1877. Out of blast.	1877. Total.
Charcoal	79	189	268	73	209	282
Anthracite	98	118	216	87	136	223
Bituminous or coke	86	132	218	84	123	207
Totals	263	439	702	244	468	712

For the first time in five years the number of furnaces in blast does not show a decrease. It will be observed that there is a decrease of 10 in the whole number reported.

Premiums to Employes.

The following awards have been made on the Southern Minnesota Railroad to the section foremen showing the best results on their respective sections for the year just closed: Matt Olson, Thomas O'Donnell, Ever Johnson, P. Sheridan, $50 each; J. Riordan, J. J. Smith, James Keegan, M. Harrington, $25 each.

Awards have also been made as follows to the locomotive engineers who killed the smallest number of animals in proportion to the miles run: James McLinden, $50; L. E. Bump, N. G. Sisson, O. Holmes, $35 each; J. Easterday, $25.

Engineer James McLinden ran 33,081 miles in passenger service during the year, and excepting hogs, only struck two animals. The other engineers named were so close behind him, that it was found difficult to decide between them.

Forging Passes.

The Louisville *Courier-Journal* of Jan. 10 says: "A young man named Ed. G. Burns, formerly an employe of the Louisville & Nashville Railroad, was arrested yesterday by officers Allen and Howard, on the charge of forgery. Burns was first the driver of the Superintendent's wagon, then time-keeper in the round-house, and finally he was discharged. For several months past he has been residing in Madison, Ind. About ten days ago he returned to Louisville, and during the past week has issued passes over the L. & N. Railroad to three persons, in the separate cases forging the names of Superintendent D. W. C. Rowland, Mr. John Slasser and Master of Transportation Metcalfe. The forgeries were promptly detected, and the matter placed in the hands of the policemen. Burns was locked up in jail, and will give an account of his transactions before Judge Price this morning."

Sales of Steel Rails.

The *Engineering and Mining Journal* reports a sale of 9,000 tons of steel rails in one lot. Also 600 tons of 56-lbs. steel rails to the Gilbert Elevated and 500 tons of 40-lbs. steel to the New York & Manhattan Beach Company. Prices about $40.

The Erie has received bids for 25,000 tons of steel rails and the contracts have been substantially awarded, but are not yet announced.

Information at Stations.

The Southern and Eastern railroad companies of France have acted on a suggestion of the Lyons Geographical Society. Beneath the names of each station they give the geographical position and elevation of the locality, the number of the population, statistics relating to the chief industries of the place, and any special facts of interest. We have heretofore recommended something of the kind for American stations, including, when practicable, maps of the immediate vicinity on a large scale, a directory of hotels, livery stables, stage routes, etc., and such other information as the arriving passenger is most likely to want to know. The French method, however, is to give information which can be displayed on the station sign and be read by the passing traveler as well as by him who lands there.

Trial of a New Street Locomotive.

The following particulars of the trial of "tramway" locomotives is given in *Iron* of Dec. 15:

"On Saturday last a trial of the first of six locomotives made by Messrs. Fox, Walker & Co., for Rouen, took place on the Bristol tramways in presence of the directors, the traffic manager and other officials of the Bristol Tramways Company. The tests were much more severe than any work the locomotives will be called upon to perform, as the Bristol tramway system is known to be the most difficult in the world, that city being built, like Rome, on seven hills. Sharp curves, in turning at right angles from one narrow street to another, and steep gradients of considerable length, are frequently met with; but the crowning point of difficulty is reached in Maudlin street, near the infirmary, where a gradient of 1 in 12 for a distance of 90 yards culminates in a curve of 45 feet radius. These combined difficulties were, however, surmounted by the engine, drawing after it a tram-car loaded with forty passengess. As we intend to illustrate the engine, we will now only give an outline description. In external appearance it resembles an ordinary tram-car, though shorter than those run on the London tramways, the whole being completely enclosed. The boiler is of the locomotive type, with extra large heating surface. The cylinders are 8 in, in diameter by 9 in. stroke, and the wheels 2 feet in diameter, all four being coupled. The noise of the exhaust is prevented by passing the steam through a wire cage and annular orifice by which it is caused to expand, and also to ascend the chimney in a volume, completely filling it. No smoke is made, as anthracite only is burnt. The steam from the safety valves is made to pass under the firebars, thus checking the fire and diminishing the pressure, The operations of starting, stopping, reversing and altering the speed are all performed by the reversing lever alone, so that the engine is more under control than a pair of horses; it may, indeed, be stopped, in this way, in its own length, while running at ten miles an hour. As an additional safeguard, and for stopping on a steep gradient, a pair of strap brakes may be applied, by means of a treadle worked by the driver, to cast-iron discs keyed on one of the axles, so as not to skid or wear away the wheels. Lifting gear is applied to both ends of the locomotive, so that it may be readily put on the track again in case of derailment.

"When it is borne in mind that the problem of producing an efficient and economical substitute for the horse on tramways is now occupying the earnest attention of several engineers, both in this country and on the Continent, it is not surprising that this trial was watched with great interest, visitors being present from all parts, including Paris and Brussels."

RAILROAD GAZETTE

Published Every Friday.

CONDUCTED BY

S. WRIGHT DUNNING AND M. N. FORNEY.

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Editorial Announcements.

Passes.—*All persons connected with this paper are forbidden to ask for passes under any circumstances, and we will be thankful to have any act of the kind reported to this office.*

Addresses.—*Business letters should be addressed and drafts made payable to* THE RAILROAD GAZETTE. *Communications for the attention of the Editors should be addressed* EDITOR RAILROAD GAZETTE.

Advertisements.—*We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

Contributions.—*Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to* ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

RAILROAD CONSTRUCTION IN 1877.

Our annual record of the construction of railroads in the United States, published this week, shows that 2,199 miles were completed in 1877, against 2,460 in 1876, 1,561 in 1875, 2,025 in 1874, 3,883 in 1873, and 7,340 in 1872. The decrease as compared with 1876 is nearly 11 per cent., but the total is above the average since the panic of 1873, that average for the four years having been 2,061 miles. Neither is it a small amount of work in comparison with the population and traffic of the country, and their rate of growth. The increase in the railroad mileage is about as great as the average increase of population in the country, and this country has long had a larger mileage in proportion to the population than any other civilized nation. We have now very nearly 80,000 miles of railroad in the country, with a probable population of 45,800,000. This gives 575 people to support one mile of railroad, and a nominal investment in railroads of about $100 per individual.

Now Europe has about 3,310 inhabitants to support one mile of railroad, or nearly six times as many as this country, and in Great Britain and Belgium—where the country is most fully provided with railroads — there are 1,860 and 2,283 inhabitants, respectively, per mile. So far as population is concerned, therefore, this country is already exceptionally well provided.

We have noticed that the construction since 1873 has been chiefly of short lines of local interest. This was especially true in 1877. The number of lines was greater than before since 1873, and the average length of each line has been smaller but once, as will appear from the following:

Year.	No. of companies.	Total built.	Average length.
1872	210	7,340	35.0
1873	137	3,883	28.3
1874	105	2,025	19.3
1875	94	1,561	16.6
1876	107	2,460	23.0
1877	117	2,199	18.8

Indeed, there were very few lines constructed in 1877 which can be called long. The longest single line was the 120 miles of the Southern Pacific extension; then follow the Minneapolis & St. Louis, 91 miles; the Colorado Central, 70 miles; the Rochester & State Line, 68 miles; the Maple River, 59 miles; the Syracuse, Geneva & Corning, 56; and the Philadelphia & Atlantic City, 54 miles. No other line as much as 50 miles long was constructed during the year.

These seven companies constructed 518 miles of the total of the year, so that the average length of the other lines was but 15 miles. In 1876 there were five companies which constructed more than a hundred miles apiece, and the eight which constructed 50 miles or more apiece built an aggregate of 898 miles, or 36 per cent. of the total.

The distribution of the new construction among the several states and territories and groups thereof for each of the past six years, with the total in each at the end of 1877, is given in the following tables:

Mileage of New Railroad Constructed in each State and Territory for Six Years.

	1872.	1873.	1874.	1875.	1876.	1877.	Total at end of 1877.
Alabama	134	2	18	0	0	1¼	1,740
Alaska	0	0	0	0	0	0	0
Arizona	0	0	0	0	0	0	0
Arkansas	156	247½	18	38½	49	0	788
California	195	85	140½	185	344¾	239	2,158
Colorado	105	121	23	111¼	154½	115	1,072
Connecticut	25	29	0	21	7	3½	921
Dakota	210	80½	0	0	0	0	290
Delaware	26½	21½	19	5	0	0	285
Florida	10½	0	18	0	0	5	489
Georgia	46	122	5	4	42	0	2,306
Idaho	0	0	0	0	0	0	0
Illinois	686½	274½	231	200	58	33	7,318
Indiana	183	84½	209½	109½	72¼	16	4,019
Indian Ter	142	0	0	0	2	0	279
Iowa	452	93	48	84½	96¾	150½	4,090
Kansas	445	36	61	0	76	86½	2,324
Kentucky	143	65¾	31¼	0	138	28¼	1,503
Louisiana	3	0	0	0	0	2	541
Maine	62½	0	37½	10	20	0	1,000
Maryland	194	34	12	17	15	0	1,107
Massachusetts	37	117½	27¾	36	5	17¼	1,854
Michigan	571	196	48	30	46	56	3,451
Minnesota	307	48	36	0	34	210	2,230
Mississippi	22	7	27	0	10	0	1,044
Missouri	314	236½	31	27	109½	16	3,162
Montana	0	0	0	0	0	0	0
Nebraska	212	41	0	22	52	69	1,219
Nevada	18	18	40	64	0	0	680
New Hampshire	43	60	45	15½	9¼	18	958
New Jersey	103	40½	39	73¼	84	81½	1,682
New Mexico	0	0	0	0	0	0	0
New York	435	242½	125¼	206	69¾	151¾	5,677
North Carolina	60	15	68	13	43	27	1,597
Ohio	456½	172	172½	26	275	236	4,923
Oregon	82	0	0	0	0	0	251
Pennsylvania	251	203	191½	136¾	90½	142¾	6,125
Rhode Island	0	22	14	0	9	9½	198
South Carolina	88	88	0	15	17	40¾	1,394
Tennessee	15	114	0	0	7½	21¾	1,667
Texas	301	385½	75	34½	387¾	179	2,264
Utah	57	85	59	27	0	20	535
Vermont	31	53	5	32	0	71	881
Virginia	49½	36	70¾	0	10	16¾	1,066
Washington T	40	50	6	0	0	52½	162
West Virginia	76	35¼	0	0	0	23	607
Wisconsin	459½	320½	102	23	123¾	54	2,761
Wyoming T	0	0	0	0	0	5	464
Total	7,340	3,883	2,025	1,561	2,450	2,199	79,669

RECAPITULATION BY SECTIONS.

	1872.	1873.	1874.	1875.	1876.	1877.	Total at end of 1877.
New England *a*	198	282	129	114	50	119	5,813
Middle States *b*	1,010	541	387	437	259	376	14,877
South Atlantic States *c*	244	261	144	32	114	84	6,962
Gulf States *d*	560	394	138	34	398	188	6,078
South Interior *e*	531	464	49	39	197	73	4,844
North Interior *f*	1,210	452	400	166	393	308	12,393
Northwest *g*	3,186	1,130	509	357	530	619	23,379
Far West Interior *h*	180	224	122	202	154	140	2,751
Pacific States *i*	317	135	147	180	345	292	2,572
Total	7,340	3,883	2,025	1,561	2,460	2,199	79,669

a *New England* includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

b The *Middle States* include New York, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia.

c The *South Atlantic States* include Virginia, North Carolina, South Carolina and Georgia.

d The *Gulf States* include Florida, Alabama, Mississippi, Louisiana and Texas.

e In the *South Interior* are included Indian Territory, Arkansas, Tennessee, Kentucky and West Virginia.

f The *North Interior* includes Ohio, Michigan and Indiana.

g The *Northwest* includes Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska and Dakota.

h The *Far West Interior* covers the district between Texas and the Northwest and the Pacific States.

i The *Pacific States* are California, Oregon and Washington Territory.

The total mileage for each State we do not make up from our own investigations, but form it by adding the mileage constructed in 1877, according to our record, to the mileage of each State represented in the last issue of Poor's Manual as existing at the end of 1876. This does not agree with previous statements, but we assume that the changes made in the last issues of the Manual are corrections.

About two-thirds of the total mileage built last year (1,418 miles) was in eight States, each of which constructed more than 100 miles. The States with largest mileage for two years past are:

1877.		1876.	
California	239	Texas	388
Ohio	236	California	350
Minnesota	210	Ohio	270
Texas	169	Colorado	155
New York	152	Kentucky	138
Iowa	150	Wisconsin	124
Pennsylvania	143	Missouri	109
Colorado	119		

The most interesting comparison is that of groups of states. In 1873 and previous the great field of railroad construction was in the upper Mississippi valley, generally known as the "Northwest," and so called in our grouping above. In 1872 42 per cent. of the total new road was in that section; in 1873 nearly 30 per cent. In 1874 this fell to 25 per cent.; in 1875 to 23 per cent.; in 1876 to 22½; while in 1877 it takes a turn and rises to 28 per cent.—a larger proportion than before since 1873. But the chief activity in the Northwest has been in Minnesota and Iowa; the former built nearly twice as much road in 1877 as in the four years preceding, and the two states together have a sixth of the total in the country. The other Northwestern states do not make much of a figure; Illinois, which for several years took the lead, and which has a larger mileage than any other state in the Union, has added very little to its excessively large railroad system. In 1872 686 miles were built in that state, which was 9 per cent. of the total of the year; in 1877 its 33 miles of new road are but 1½ per cent. of the total.

If, however, there has been a restriction of work in one state where the supply is excessive, the contrary has been the case in another. Ohio, which has more non-paying railroads than almost any other state, has largely increased its mileage, and constructed 10½ per cent. of the total in the country. There is to be said of Ohio, however, that, in the first place, though the railroads are much too near together for their own good in most of the state, part of it, until very recently, has been quite destitute; and, moreover, Ohio has become a manufacturing state, with developing business in mining, etc., which may not always be properly served by the old system built chiefly for other objects. At least nearly all the new Ohio roads are local lines, without even a pretence of aiming at that "great through traffic" which has begot and ruined so many railroads in the West and elsewhere. The new Ohio lines are chiefly true secondary railroads, intended to fill a place between the highway and the trunk line, to be worked at moderate speed to accommodate a local traffic. Out of the 236 miles credited to that state, no less than 157 are of 3-ft. gauge, and made light and cheap. The lightness and cheapness are in every way commendable for roads of their class, but in a state so well supplied with standard roads the narrow gauge will be a much greater disadvantage than in isolated districts like those of Colorado and Utah, where there is a narrow-gauge system which it is often important to conform to.

The mileage of narrow-gauge road constructed last year in the entire country is very large—705 miles, and nearly one third of the total. As we have frequently said, there is now little room for costly roads, and it is natural and proper that most of the new ones should be adapted to their circumstances and made cheap and light; and as the only cheap and light railroad with which the community of this generation at large is familiar is of narrow gauge, we may expect their construction to continue until examples of equally cheap railroads of standard gauge are frequent enough to be generally known.

Although the last half of the year was more prosperous than the first half, railroad construction does not seem to have been much affected thereby, the proportion constructed in the last half being about as usual. Naturally we would expect any improvement in business to be felt later, and, if at all, during 1878. We do not, however, yet hear of any unusual number of new projects which are likely to be undertaken. There are, however, a number of unfinished lines on which work is now in progress. Of the lines on which road was built last year, 44, according to our best information, are still in progress or likely soon to be extended further, while several more may have work resumed on them. Most of them, however, will be short lines when they are finished, and we hear of no long line which is sure to be constructed in 1878, though the extension of the Cincinnati Southern is altogether probable, we suppose. The farther rapid building of the Texas & Pacific will depend, we suppose, on the action of Congress, and also to some extent that of the Southern Pacific. The latter will probably make some extension into Arizona, unless the Texas & Pacific is subsidized all the way to Fort Yuma, but not if it is. The Northern Pacific may do something towards completing its great line, but probably not a great deal. A number of Texas roads are ready to be built long distances if the money can be got; but no great revival of construction can be looked for this year. A second heavy harvest in the Northwest would probably stimulate immigration, and there is plenty of room in good land for railroads in Western Minnesota and Iowa and Eastern Nebraska, if only people will establish farms there. But again the chief part of the work will probably be for local roads, for which there is abundance of room east and west, if made strictly to suit their circumstances—very light, very cheap, and worked at very low speeds.

OIL.

On another page will be found the very interesting lecture by Professor Thurston delivered at the December meeting held at the rooms of the Master Car-Builders' Association in New York. It will no doubt do a great deal to shed light on this little understood subject, and is one of the first attempts that we know of at formulating the knowledge which we have on this subject. Not that any pretensions were made at completeness, because the address was entirely extemporaneous, and was not the work of careful preparation. The fact is that all the existing knowledge of this subject seems to be entirely fragmentary. Thus far it has not undergone what Herbert Spencer would call a process of "evolution," and has not advanced from a state of "homogeneity" to "hetrogeneity." The condition of our knowledge of lubricants is somewhat analagous to the early stages, or rather the immature condition, of medical science, of which there are unfortunately still plenty of examples. The tendency of such partial knowledge is to

attribute health and disease to some one cause, and to seek for sovereign cures for all the ills of life. Thus the theory has been advanced that all disease proceeds from the stomach, that it is due to eating animal food, or to the use of alcohol, that it always proceeds from "germs," and so on in an almost interminable list. The fact is, however, that disease and health are in some way related to all these causes. As knowledge increases, the precise relation existing between the cause and effect is more clearly understood. The evolution of knowledge on any subject is characterized by a continuous multiplication of information, but at the same time the new ideas form a part of a complete system. To each previously unknown quantity an exact value is assigned, and "an essential characteristic of advancing science is increase in *definiteness.*"

At present what is known about the qualities of oil is extremely indefinite, and to that extent is unscientific, and it will be noted that heretofore some one test has been sought with which to determine the value of oil. A person who had much experience in the compounding and sale of oils remarked to the writer that the best lubricating oils always "smell the worst." Another, that the lubricating quality was due to the "capillarity" of oil, that is, that the oil which would rise the highest in a lamp wick would lubricate the best. Illuminating power and the lubricating quality have also been said to go together. What seemed to be the most effectual test, however, was that of friction. Thus the sole purpose which it seemed a lubricant should fulfill was to lubricate the rubbing surfaces of machinery and prevent them from heating and abrading. Therefore it seemed quite practicable to make a machine on which this quality of an oil could be tested. Accordingly this has been done, and besides the machines which are illustrated and described in the lecture of Professor Thurston, a great many others have been constructed and used. But it has been found that if the lubricating quality of an oil is determined, we then know only one of the essentials which it must possess. Undoubtedly a good lubricating oil must lubricate well, but it must do or not do a number of other things. Thus linseed oil is said to be a fair lubricant. If now it should be tested on a frictional testing machine, and it should hastily be concluded therefrom that it could be used for oiling car-journals, a few weeks' experience would show that, owing to its drying properties, the journals become gummed up to such a degree as to make it quite out of the question to use it for that purpose. Therefore in testing the value of an oil we must determine not only its lubricating property, but must also know whether it will dry or "gum up," which can probably be found by Nasmyth's method, described in a note to Professor Thurston's lecture.

One of the qualities which it is found that a good lubricating oil must possess is what is called "body." This term is often used vaguely, and is confused with the weight or specific gravity. It is used here in the sense of thickness or viscidity, as molasses may be said to have much "body," that is, it is thick or viscid and does not flow freely, while water or alcohol has little "body." It was found that paraffine was a good lubricant, as shown by the experiments quoted on another page.* That is, when placed on a testing machine, it endured a larger number of revolutions of the machine without heating than any other oil. These experiments led to its adoption as a lubricant on a prominent railroad. It is said that the difficulty encountered was that it had not sufficient body to be retained by the waste with which the boxes were packed, and which was saturated with the oil, but that in a few hours the paraffine would all drain down to the bottom of the box, and thus would not feed up to the axle. Now if this is true (our information is not very exact or definite), it indicates that in testing oil we must find out whether the oil will lubricate, whether it will gum, and whether it has sufficient "body" to remain mixed with the waste. Some investigations have been made to determine the relation between the capillarity of oil - that is, its capacity for being drawn up a lamp wick—and its lubricating power. But little is known, however, about it. It may be, however, that an oil with a high degree of capillarity would have the quality which the paraffine had not. So that possibly this too is one of the qualities which should be determined in testing oil.

The weight or specific gravity of oil, especially mineral oil, has much to do with its value as a lubricant, so that it is one of the most ordinary tests applied. On the Baltimore & Ohio Railroad a natural West Virginia mineral oil is used of 32 gravity, reduced by distillation to 29 or 30 in winter and 27 to 28 in summer. The relation which exists between the specific gravity, the body and the capillarity of oil, and their influence on their lubricating value is not understood, but it offers a very inviting field for investigation. The first can easily be determined by a hydrometer, the second, either by the relative amount of rapid flow in an instrument like Nasmyth's, or by filling a vessel having a small orifice with a given quantity of oil at a certain temperature and observing the time required for the oil to run out. The capillarity can be tested by suspending either lamp wicks or strips of brown paper in different samples of oil and observing the height to which it will rise.

In testing on a frictional machine there are two things that should be determined, one the endurance of the oil—that is, the number of revolutions made for a given quantity - and the other the amount or the co-efficient of friction. One oil may have a low co-efficient of friction, but have little endurance. Another oil may have a high co-efficient of friction and great endurance.

Although oils are used to prevent journals from heating, it must be kept in mind that hot boxes will always occur, and that the lubricant used must be suited to such an accidental condition of things. In other words, if an oil vaporizes at a comparatively low temperature, in case a box gets hot such oil is liable to leave the bearing dry, or take fire, and so in either case aggravate the evil. For this reason the fire test is used, as explained by Professor Thurston. On the other hand, oil to be used in winter must not be liable to congeal at the temperature to which it is exposed.

Some of the mineral oils are very apt to be adulterated with the refuse of refineries in order to give them the requisite specific gravity. Such adulterations can be discovered by the use of a microscope. By observing the oil with such an instrument, solid black particles will be found all through the liquid. Doubtless the microscope could also be used in discovering other adulterations and impurities.

A great deal of injury is often done to machinery, especially to the cylinders, valves and steam-chests of locomotives, by the use of oils containing acid due to the use of rancid fat. The presence of this can be detected by chemical tests. A very simple one is to place the oil in a copper kettle. The presence of acid will be indicated by the change of color of the copper around the edge or surface of the oil.

These different tests of oil have been enumerated not with any idea that they are at all complete or that they would in any sense be a guide for the inspection of oils, but for the purpose of showing that no one test will determine the value of an oil. It would be possible, however, we believe, to establish in connection with every railroad, in a small room, a laboratory provided with comparatively simple instruments, the use of which could be readily understood and learned in a short time by an intelligent mechanic, and in which the value of oils as lubricants and illuminators could be very accurately determined. It is true that the ultimate test on a railroad must be that of the cars, engines and other machinery, a record of the performance and cost of which should be used as a check on the laboratory. The rolling stock is, however, a very expensive testing machine to operate, and the injury and loss which will result in case bad material is used will be very much greater than the cost of maintaining such a testing department. One of the gratifying indications at the present time is the fact that a number of railroad companies have established departments for the inspection of all material used on their lines. The expense of such a department is comparatively little if it embraces all the material used on a railroad, and with a competent person at its head it would give an opportunity for original research to one or more persons, should their duties not absorb all their time, as is usually the case with the heads of the present departments on most of our lines.

The value of such an inspection department will of course depend almost entirely on the qualifications of the person at its head. If he is competent it would undoubtedly prove to be very useful; if he is not, or, what would be worse, if he is open to bribery or other dishonesty, it would soon degenerate into a hot bed of corruption.

The Brevoort House Conference.

The trouble about east-bound rates seems in a fair way to be settled without further losses. Indeed, whenever the representatives of the companies get together and express their opinions, there seems to be no difficulty in reaching a harmonious conclusion. The trouble seems to be, if reports may be trusted, that some managers forget their good resolutions and solemn promises after they leave the meetings, and do those things which they ought not to do.

The origin of the recent trouble is traced to a struggle for Milwaukee traffic, which this year, when there is an enormous wheat traffic, is very important—in grain certainly standing next to the Chicago traffic. Milwaukee has a route to the sea-board which is connected with none of the combinations—across Lake Michigan to Grand Haven, thence by the Grand Trunk to Portland, Boston and New England generally. About 60 miles of this route are by lake, which, at least in winter, makes it inferior to the all-rail route by way of Chicago; at least it cannot command traffic at the same rates. In connection with the trunk lines, however, the Detroit & Milwaukee makes the shortest route to Milwaukee, and it always gets a very large share of the Milwaukee traffic, usually charging a little less than the regular rate by way of Chicago. One of its effects (though the lake also has a good deal to do with that) is to make the all-rail rate as low to and from Milwaukee as that to and from Chicago, though the distance to Milwaukee is 85 miles greater. This is as if New York rates were made as low as Philadelphia rates, or Boston rates as low as New York rates (which latter is practically the case). This season, however, not only is the Milwaukee traffic unusually large, but the Detroit & Milwaukee route has been an unusually favorable one. Whatever may be the risks of delay, etc., due to the long ferry across Lake Michigan, they ordinarily are greatest in the winter, when probably few are aware that any navigation can be kept up on that body of water. But the mildness of the present winter has made this route as safe and unobstructed as in midsummer. It, thus, was better able than usual to secure traffic by a reduction of rates; and we understand that the first "cutting" by the lines in the combination was in the Milwaukee rate, to prevent too great a diversion to this lake-and-rail route; while of course the Milwaukee rate could not permanently be kept lower than the Chicago rate.

This is not the first time that 180 miles of bankrupt railroad has threatened a whole season's business.

The maintenance of agreements among the other lines may prevent the conduct of traffic by the Grand Haven route in connection with the lines from Detroit to the Niagara River to New York, but not by the Grand Trunk to Boston and Portland, so long as the Grand Trunk remains outside of the combination. Naturally, however, most of the Milwaukee traffic tends to New York, and not to ports reached by the Grand Trunk. And, again, while the Detroit and Milwaukee is primarily interested in the Milwaukee traffic, which is all the through traffic that it can get, the Grand Trunk has an interest in all Northwestern traffic and in the maintenance of rates on it; so that it may be persuaded to join in a movement against such a depression in rates by the Grand Haven route as will give the latter an extraordinary share of the Milwaukee business. The Grand Trunk gets a share of the Milwaukee business coming by way of Chicago, and of Chicago business, and it will not be likely to destroy the value of these without some important gain to balance such loss.

We publish elsewhere the substance of the action had at the Brevoort House conference in New York Thursday of last week (Jan. 10). Briefly, we may say, it affirms the regulations previously made, and declares that the trunk lines will enforce the penalty if any of their connections are duly shown to have taken traffic at less than the regular rates; and recommends that if any Western line, whether or not a party to the agreement, persists in such reduced rates, the lines which have joined in the appointment of the Western Commissioner shall act together in meeting such reduced rate. This action gives strength to the combination for maintaining rates; for it comes from the managers of the lines which have been most complained of for cutting, who seem thus to have declared that their action was a necessity, to meet the rates of lines out of the combination; and who now agree hereafter not to take such action separately, but only in conjunction with the other roads, so that the rates made, however low they may be, will be regular and public rates, made by all alike.

The prospect is, that the roads being agreed and joining in the establishment of the office, the Western Commissioner will be of the greatest use in bringing about united action. He can hear all parties at leisure, arrive at the facts with something like certainty, hear and compare all recommendations, and suggest a policy, when it is necessary to take action, especially adapted to the object in view; and the united action of so many lines on some definite plan will be much more likely to secure the object aimed at than the desultory and often contradictory actions of the lines separately, It will be an army in the place of a horde of guerrillas.

The action of last week does not, it is true, insure the maintenance of rates; but it does make it very improbable that there will be any war among the great companies. They will act as allies for the maintenance of rates, if possible, in peace, but if not, then with joined forces against the common enemy.

Locomotive Adhesion.

In an article published last week it was stated that "it has usually been considered necessary to add to the weight of the train that of the locomotive in calculating the adhesive weight. It has recently been pointed out that this is unnecessary, because no adhesion of the driving-wheels is needed to overcome the friction of the mechanism of the engine." This subject was discussed in a paper by J. Moschell, Engineer in Chief of the District Railroad of the Jura, which originally appeared in *Annales du Genie Civil* of March, 1874, and the following abstract of it appeared with the published proceedings of the Institute of Civil Engineers:

"The author states that ordinarily, after having determined the total tractive force which can be produced by the adhesion of any particular locomotive on the rails, engineers deduct therefrom a certain proportion, as being required for the locomotive itself, and treat the residue only as available for overcoming the resistance of the tender and of other parts of the

* We are inclined to believe that there must be some error in these experiments. The results are so different from those indicated by other observations that they require confirmation before being implicitly accepted.

train. The author is of the opinion that engineers make this deduction on a basis that the friction between the wheels and the rails has to overcome the resistance of all the moving parts of the engine, and he enters into elaborate arguments with illustrations to show that it is the steam which has to overcome this resistance, and that the adhesion of the engine is not called upon to play any part in this matter.

"Further, he directs attention to the fact that by coupling a second pair of wheels in a locomotive, so as to turn them into drivers, not only is the adhesion available for traction increased by the effect of the weight upon the other pair of driving wheels thus brought into play, but that the adhesion formerly employed to overcome the journal friction of these wheels is no longer necessary. By assuming a proportion between the diameter of the wheel and that of the journal of 7 to 1, and a load of 10 tons upon the pair of wheels, with a friction on the journals of $\frac{1}{10}$, he proves that 160 lbs. out of the whole adhesion, required to overcome the friction of the journals, are now set at liberty for the purpose of assisting in drawing the train; and he attributes to this fact the explanation of a matter observed by M. Flachat, viz., that the adhesion of two pairs of coupled wheels was a greater percentage of the insistent weight than that afforded by the adhesion when one pair of driving wheels only was employed. M. Flachat explained this discrepancy by assuming that the wheels were not truly of the same diameter, and that thus there was a slight grinding action which increased the adhesion. The author, however, believes that he has found the solution in dispensing with the journal friction of the pair of wheels."

This view is undoubtedly correct regarding the friction of the working parts of the engines proper, including that of the driving-axles, but further reflection has led us to see that the principle does not apply to the resistance due to the weight of the engine in ascending a grade, to overcome which there must be a corresponding amount of adhesion of the driving wheels to the rails. This was illustrated in the working of the temporary line over the Board Tree Tunnel on the Baltimore & Ohio Railroad by Mr. Latrobe. The grades were $\frac{1}{10}$ or 528 feet per mile. In some unfavorable conditions of the weather the adhesion of the engine was not sufficient to take up its own weight, but in some cases the engine would slide down the incline in spite of its own exertions to go up. Further consideration, therefore, leads us to dissent from the opinion expressed in the above abstract and to conclude that in calculating the amount of adhesion required to take a train of a known weight up a given grade the weight of the engine should be included as a part of the load.

We have been promised a report of some very interesting experiments on this subject which will be published as soon as received. More exact and definite knowledge regarding it is much needed.

A "LOCOMOTIVE ENGINEER" is almost universally understood in this country to mean a man who runs a locomotive; and though many protest against the use of the word "engineer" in this sense as confounding the man who designs and constructs with him who works the machine, yet none of these would expect the former class to be understood if the term "locomotive engineer' was used. But we find it used in England with this logical and natural meaning, such use being possible there because there is a distinct term for the man who operates the locomotive, who is never called a "locomotive engineer,' apparently. A recent advertisement in English papers shows this, and really defines the English use of the term locomotive engineer; at the same time it illustrates a practice of the English companies in selecting employes which is very rare here. This advertisement is by the London & Southwestern Railway Company, the directors of which say that they "require a locomotive engineer, to superintend the locomotive, carriage and wagon departments of the company." They further say that all applicants must have "a thorough, practical knowledge of the construction and maintenance of locomotive engines and rolling stock, and experience in the working of the same."

TERMINAL CHARGES are a subject of great complaint against New York, but to get the full benefit of them one needs go to Vera Cruz. The Mexican Railway people complain that the bare landing charges at that port, levied on goods transferred to and from the steamers and other vessels (which cannot come up to wharves for lack of water) are *five dollars a ton*—equivalent to 15 cents a bushel on wheat and about as much as the ordinary charge from New York to Liverpool.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

Atlantic & Gulf.—The following circular is issued by General Superintendent Haines:

"1. On and after Jan. 1, 1878, the duties of Auditor of Earnings and of General Ticket Agent will be assumed by the Accountant, to whom employes in those offices will report for assignment to such work as he may see fit in the reorganization of his office.

"2. Mr. George S. Haines will assume the duties of Assistant General Freight and Passage Agent."

Augusta & Savannah.—At the annual meeting in Savannah, Jan. 7, the following directors were chosen: Wm. Duncan, A. R. Lawton, George S. Owens, John Davidson, John L. Hardee, Henry Hull, Ferdinand Phinizy. The road is leased to the Central, of Georgia.

Baltimore & Ohio.—At a meeting of the board of directors in Baltimore, Jan. 9, the appointments of M. L. Doherty as General Freight Agent and N. S. Hill as Purchasing Agent were confirmed.

Central, of Georgia.—At the annual election in Savannah, Ga., Jan. 7, the following directors were chosen. Clinton I. Brown, Atlanta, Ga.; W. B. Johnston, J. J. Gresham, Macon, Ga.; W. M. Wadley, Andrew Low, E. C. Anderson, G. M. Sorrel, George Cornwell, W. W. Gordon, J. Rauers, H. H. Epping, Savannah; W. R. Garrison, Moses Taylor, New York.

Buffalo & Southwestern.—Mr. Charles A. Brunn has been appointed Assistant Superintendent, and Joseph Deuel General Freight Agent.

Champlain Transportation Co.—At the annual meeting recently the following directors were chosen: I. V. Baker, Comstock's, N. Y.; V. P. Noyes, Burlington, Vt.; John B. Page, Z. V. K. Wilson, Rutland, Vt.: A. L. Inman, Crown Point, N. Y.; George B. Chase, Boston; Legrand B. Cannon, New York. The board elected Legrand B. Cannon President; I. V. Baker, Vice-President; P. W. Barney, Clerk and General Superintendent; V. P. Noyes, Treasurer; E. Root, Chief Engineer.

Chicago, Rock Island & Pacific.—Mr. A. H. Caffee is appointed General Southern Freight Agent, with office in Cincinnati.

Mr. H. J. Gleason, late agent at Atchison, Kansas, is appointed Freight Agent in Chicago, in place of C. W. Maybury, resigned.

Chicago & Eastern Illinois.—Mr. O. S. Lyford has been appointed Superintendent, in place of E. L. DuBarry, resigned. He was formerly General Superintendent of the Kansas Pacific, and was at one time on the Hannibal & St. Joseph.

Cincinnati, Wabash & Michigan.—Mr. Norman Beckley has been appointed General Manager for the Trustees. He was recently Division Superintendent on the Lake Shore road.

Columbus & Northwestern.—At the annual meeting in Urbana, O., Jan. 8, the following directors were chosen: Lemuel Weaver, J. H. Young, F. E. Hoover, R. G. Dun, Wm. Jamison, E. Jennings, H. Cargill, J. E. Williams, Gen. Morgan, I. Burnside, J. H. Beach, I. N. Hutchinson. The board elected officers as follows: President, Lemuel Weaver, Urbana, O.; Vice-Presidents, Wm. Jamison, Gen. Morgan and J. E. Williams; Secretary and Treasurer, A. W. Thurman, Columbus, O.

Dayton & Southeastern.—At the annual meeting in Dayton, O., last week, the following directors were chosen: D. E. Mead, Daniel Keifer, W. P. Callahan, T. A. Legler, S. F. Woodsum, George L. Phillips, M. C. Allison, F. C. Trebein, John Little, A. J. Christopher, John L. Persinger, Daniel McLean, D. C. Anderson, S. F. McCoy, H. F. Austin. Messrs. Woodsum, Phillips, Little and McLean are new directors, replacing W. H. Simms, Preserved Smith, S. N. Yeomans and T. Woodrow. About 3,000 votes were cast for an opposition ticket.

Delphos & Kokomo.—At the annual meeting in Delphos, O., Jan. 9, the following directors were chosen: Joseph Boehmer, C. A. Evans, D. W. Evans, N. C. Miles, D. H. Tolan, D. L. Williams.

East Broad Top.—At the annual meeting in Philadelphia, Jan. 14, the following were chosen: President, William A. Ingham: Directors, Ario Pardee, George B. Markle, Edward Roberts, Jr., Edward R. Wood, Percival Roberts, Charles Hacker, Franklin A. Comly.

Grand Rapids, Newaygo & Lake Shore.—Mr. Chester Warren, Secretary and Treasurer, is appointed Superintendent also, in place of A. W. Hooper, resigned.

Jacksonville, Pensacola & Mobile.—Mr R. D. Carpenter has been appointed General Freight and Ticket Agent, in place of F. B. Papy, resigned. Mr. John P. Laird has been appointed Master of Transportation and Master Mechanic.

Lehigh Valley.—At the annual meeting in Philadelphia, Jan. 15, Hon. Asa Packer was re-elected President, with the following directors: Wm. W. Longstreth, J. Gillingham Fell, Wm. H. Gatzmer, Wm. S. Ingham, Joseph Wharton, Philadelphia; Robert H. Sayre, Bethehem, Pa.; David Thomas, Catasauqua, Pa.; George B. Markle, Ario Pardee, Hazleton, Pa.; Wm. L. Conyngham, Wilkesbarre, Pa.; Ashbel Welch, Lambertaville, N. J.

Lowell & Lawrence.—At the annual meeting in Lowell, Mass., Jan. 7, the following directors were chosen: Wm. E. Livingston, John E. Kimball, Hocum Hosford, Edward Tuck, H. C. Howe, Joseph Shattuck, Wm. R. Spaulding The road is leased to the Boston & Lowell.

Mexican Railway.—Mr. Thomas Braniff, who is, we believe, an American, is chosen a member of the board of directors in Mexico and will have the active direction of affairs there. He was a contractor on the road during its construction, and afterward and until recently its Manager.

Miami Valley.—At the annual meeting in Lebanon, O., Jan. 7, the following directors were chosen: D. Allen, D. R. Cox, S. S. Havens, H. H. Hoffman, S. Irons, John Perrine, L. A. Rohman.

Missouri, Iowa & Nebraska.—At the annual meeting in Centerville, Ia., Jan. 7, the following directors were chosen: B. E. Smith, C. A. Secor, George Opdyke, M. D. W. Loomis, S. S. Stowe, Henry Hill, F. M. Drake, A. B. Stone, J. A. Talbot, Wm. Bradley, George S. Knox, John E. Walker, James Fitz Henry. The board re-elected F. M. Drake, President; Henry Hill, Vice-President and General Superintendent; James Fitz Henry, Secretary and Treasurer.

Montpelier & Wells River.—At the annual meeting in Montpelier, Vt., last week, the following directors were chosen: T. P. Redfield, Montpelier, Vt.; S. S. Thompson, Lyndonville, Vt.; W. H. H. Bingham, Stowe, Vt.; D. R. Sortwell, E. C. Sherman, Boston. The board re-elected D. R. Sortwell President; Joel Foster, Jr., Clerk and Treasurer; W. A. Sortwell, Superintendent.

Nesquehonina Valley.—At the annual meeting in Philadelphia, Jan. 14, the following were chosen: President, J. B. Moorhead; Directors, George Whiting, Samuel Mason, Francis R. Cope, E. W. Clark, Charles Wheeler, Fisher Hazard, P. C. Garrett, A. J. Derbyshire, I. N. Williamson, George F. Tyler, T. C. Henry, Henry Handy. The road is leased and worked by the New Jersey Central.

New York, New Haven & Hartford.—At the annual meeting in New Haven, Jan. 9, the old board was re-elected, as follows: Chester W. Chapin, Springfield, Mass.; C. M. Pond, Henry C. Robinson, Hartford, Conn.; E. M. Reed, E. H. Trowbridge, George H. Watrous, New Haven, Conn.; Wm. D. Bishop, Nathaniel Wheeler, Bridgeport, Conn.; Wilson G. Hunt, George N. Miller, Augustus Schell, Abraham R. Van Nest, Wm. H. Vanderbilt, New York.

Northern Pacific.—Mr. A. P. Farrar, late of Jackson, Mich., has been appointed Master Mechanic, in place of W. H. Lewis, resigned. His office is at Brainerd, Minn.

Northeast Pennsylvania.—At the annual meeting in Philadelphia, Jan. 14, the following were chosen: President, Franklin A. Comly; Directors, John Jordan, Jr., J. Gillingham Fell, William C. Ludwig, Ellwood Shannon, Edward C. Knight, Alfred Hunt, James H. Stevenson, Jacob Riegel, Richard J. Dobbins, G. J. Mitchell, Isaac Warner, Jr., George Fulmer. The road is leased to the North Pennsylvania.

North Pennsylvania.—At the annual meeting in Philadelphia, Jan. 14, Franklin A. Comly was re-elected President, and the following directors chosen: John Jordan, Jr., J. Gillingham Fell, William C. Ludwig, Elwood Shannon, Edward C. Knight, Alfred Hunt, Thomas Smith, Ario Pardee, James H. Stevenson, Jacob Riegel, Richard J. Dobbins, Charles A. Sparks.

Norwich & Worcester.—At the annual meeting Jan. 9 the following directors were chosen: A. F. Smith, John F. Slater, Norwich, Conn.; E. L. Davis, F. H. Dewey, George W. Gill, Charles W. Smith, Worcester, Mass.; Wm. F. Weld, Boston; Robert Bayard, New York. The board elected A. F. Smith, President; Edward T. Clapp, Clerk; G. L. Perkins, Treasurer.

Ohio & Baltimore Short Line.—At the annual meeting in Washington, Pa., Jan. 14, J. B. Washington was chosen President, with the following directors: Dr. Thomas McKennan, W. W. Smith, S. B. Hayes, Wm. Workman, Wm. Keyser, J. Harrison Garrett, John K. Cowen. The board elected W. W. Smith Secretary; W. H. Ijams, Treasurer; W. T. Thelin, Auditor; J. L. Randolph, Chief Engineer.

Ohio & Mississippi.—Mr. Thomas Avery has been appointed General Baggage Agent, in place of B. N. Robinson, resigned.

Ohio & Toledo.—At the annual meeting in Minerva, O., Jan. 7, the following directors were chosen: A. R. Arter, J. F. Jerome, E. McGuire, J. Russell, W. C. Scott, Nelson Smith, John Sterling, G. W. Yost, T. D. Yost. This is almost entirely a new board, Messrs. Arter and Scott being the only old directors left.

Pennsylvania.—At the annual meetings of this company's leased and controlled lines in Philadelphia, Jan. 14, the following officers and directors were chosen: *Mifflin & Centre County.*—President, Strickland Kneass; Directors, Josiah Bacon, Alexander Biddle, J. N. Du Barry, George W. Elder, John P. Green, John M. Kennedy, Samuel Maclay, James H Mann, Wistar Morris, George B. Roberts, Thomas A. Scott, Edmund Smith. *Southwest Pennsylvania.*—President, G. B. Roberts; Directors, D. R. Davidson, A. J. Derbyshire, J. N. Du Barry, John K. Ewing, R. W. Hogsett, Strickland Kneass, Israel Painter, B. T. Ruff, Thomas A. Scott, Edmund Smith, George A. Torrence, J. T. Wentling. *Bedford & Bridgeport.*—President, John Cessna; Directors, John Alsop, G. W. Anderson, Josiah Bacon, William Chenawith, J. N. Du Barry, John G. Hartley, John M. Kennedy, Strickland Kneass, John W. Langenfelter, Wistar Morris, Geo. B. Roberts, Edmund Smith. *Columbia & Port Deposit.*—President, Strickland Kneass; Directors, Thomas A. Scott, George B. Roberts Edmund Smith, J. N. Du Barry, Wistar Morris, Josiah Bacon, John M. Kennedy, N. Parker Shortridge, Alexander Biddle, Joseph Lesley, Jacob Tome, Morris Hoopes. Sec. James R. McClure was elected by the board Secretary and Treasurer. *River Front.*—President Thomas A. Scott; Directors, George B. Roberts, A. J. Cassett, Strickland Kneass, J W. Du Barry, Wistar Morris, Josiah Bacon, Samuel M. Felton and N. Parker Shortridge. By the board—Secretary and Treasurer, James R. McClure. *Western Pennsylvania.*—President, Strickland Kneass; Directors, Geo. B. Roberts, Josiah Bacon, Edmund Smith and Wistar Morris. By the board—Secretary and Treasurer, James R. McClure. *Philadelphia & Trenton.*—Directors, Strickland Kneass, N. Parker Shortridge, Josiah Bacon, Wistar Morris, A. J. Derbyshire, John M. Kennedy, Alexander Biddle, Henry M. Phillips, Thomas A. Scott, J N Du Barry, George B Roberts, George M Dorrance. By the board—President, Strickland Kneass; Secretary, James A. McClure; Treasurer, Dr. William Taylor. *Philadelphia & Merion.*—G B Roberts, President; Josiah Bacon, R D. Barclay, A. J. Derbyshire, J. N. Du Barry, John P. Green, Strickland Kneass, Joseph Lesley, Wistar Morris, Thomas A. Scott, N P. Shortridge, Edmund Smith, W. M. Spackman, directors.

Pennsylvania & New York.—At the annual meeting in Philadelphia, Jan. 14, the following were chosen: President, Robert H. Sayre; Directors, Asa Packer, William W. Longstreth Charles Hartshorne, John J. Taylor, Garrett B. Linderman, Robert Lockhart, Victor E. Piollet, Robert A. Packer, J. Henry Swoyer, John W. Hallenbeck, William H. Sayre, E. P. Wilbur. The road is controlled by the Lehigh Valley.

Philadelphia Wilmington & Baltimore.—At the annual meeting in Wilmington, Del., Jan. 14, the following directors were chosen: Isaac Hinckley, Wm. Sellers, Philadelphia; Samuel M. Felton, Thurlow, Pa.; Joseph Bringhurst, Samuel Harlan, Jr., Charles Warner, Wilmington, Del.; Jacob Tome, Port Deposit, Md.; Thomas Kelso, Enoch Pratt, Samuel M. Shoemaker, Thomas Whitridge, Baltimore; Nathaniel Thayer, Wm. Minot, Charles P. Bowditch, Robert H. Stevenson, Boston. The only new director is Mr. Whitridge, who succeeds Thomas Donaldson, deceased. The board re-elected Isaac Hinckley President; Enoch Pratt, Vice-President; Alfred Horner, Secretary and Treasurer; Robert Craven, Assistant Treasurer.

Philadelphia & Reading.—At the annual meeting in Philadelphia, Jan. 14, Franklin B. Gowen was re-elected President, with the old board of managers, as follows: H. Pratt McKean, A. E. Borie, J. B. Lippincott, John Ashhurst, Henry Lewis, I. V. Williamson; Secretary, David J. Brown; Treasurer, Samuel Bradford.

Philadelphia & Reading.—At the annual meetings of the leased and controlled lines in Philadelphia, Jan. 14, the following officers and directors were chosen: *Chester & Delaware River.*—President, G. A. Nicholls; Secretary, Howard Hancock; Treasurer, John Welch; Directors, H. P. McKean, A. E. Borie, J. B. Lippincott, John Ashhurst, F. B. Gowen, William Ward. *East Pennsylvania.*—President, G A. Nicholls; Treasurer, John Welch; Secretary, Howard Hancock; Directors, A. E. Borie, J. B. Lippincott, F. B. Gowen, I. V. Williamson, Thomas Hart, Jr., Moran P. Henry, George D. Stitzell, Joseph S. Stichter. *Reading & Columbia.*—President, G. A. Nicholls; Secretary, Howard Hancock; Treasurer, John Welch; Directors, H. P. McKean, A. E. Borie, J. B. Lippincott, John Ashhurst, F. B. Gowen, Henry Lewis, I. V. Williamson, Frederick Lauer, George Bogle, W. G. Case, Thomas Baumgardner, Samuel Small. *Mine Hill & Schuylkil Haven.*—President, Samuel Mason; Managers, Alexander J. Derbyshire, Frederick Fraley, James H. Creason, Charles H. Hutchinson, Samuel M. Bines, John W. Biddle, Benjamin H. Shoemaker, Wm. Hacker, Alfred Jones, John E. Carter. *Alentown & East Mahanoy.*—President, G. A. Nicholls; Treasurer, John Welch; Secretary, Howard Hancock; Directors, H. P. McKean, A. E. Borie, J. B. Lippincott, John Ashhurst, F. B. Gowen, I. V. Williamson. *Chester Valley.*—President, John F. Gilpin; Directors, F. B. Gowen, Coffin Colket, H. P. McKean, A. E. Borie, J. B. Lippincott, John Ashhurst, Wm. H. Holstein. *Lancaster & Reading.*—At the annual meeting in Lancaster, Pa., Jan. 7, the following directors were chosen: C. A. Bitner, F. Von A. Cabeen, Henry Carpenter, G. W. Hensel Daniel Herr, C. M. Hess, Amos Hollinger, John Keller, W. H. Kemble, A. H. Peacock, W. L. Peiper. R. W. Shenk, John D. Skiles. *Little Schuylkill Navigation, Railroad & Coal Co.*—At the annual meeting in Philadelphia, Jan. 9, the following were chosen: President, Alexander J. Derbyshire; Managers, Samuel F. Ashton, Daniel B. Bennett, Adolph E. Borie, Samuel J. Reeves, George W. Steiner, Joseph H. Trotter; Secretary and Treasurer, Joseph Lapsley Wilson.

Pittsburgh, Virginia & Charleston.—At the annual meeting in Pittsburgh, Jan. 14, the following directors were chosen: J. N. DuBarry, H. B. Hayes, B. F. Jones, George V. Lawrence, Alexander Patton, John Scott, D. A. Stewart, M. B. Thompson, Jos. Walton. Mr. John Scott was chosen President, and B. F. Jones, Vice-President.

Salem & Lowell.—At the annual meeting in Lowell, Mass., Jan. 8, the following directors were chosen: D. S. Richardson, A. B. Buttrick, A. Putnam, George Runnells, R. H. Butcher, F. E. Clark, H. G. Herrick. The road is leased to the Boston & Lowell.

Sioux City & Pacific.—Mr. F. C. Hills has been appointed Superintendent, in place of L Burnett, resigned. Mr. Hills will continue to act as General Freight and Passenger Agent also. Mr. J. E. Ainsworth has been appointed Chief Engineer, and will have charge of the construction and maintenance of road-bed, track, bridges and buildings. Offices at Missouri Valley, Iowa.

Springfield, Jackson & Pomeroy.—At the annual meeting in Springfield, O., Jan. 9, the following directors were chosen: B. H. Warder, John Foos, Amos Whiteley, Wm. M. Whiteley, Springfield, O.; James Purcell, Washington Court House, O.; W. W. Bell, Greenfield, O.; H. L. Chapman, Jackson, O.

St. Louis, Keokuk & Northwestern.—Mr. W. H. Harris, of Cleveland, O., has been chosen Treasurer, in place of H. B. Blood, resigned. Col. Blood continues as Secretary and General Freight Agent.

St. Louis, Vandalia & Terre Haute.—At the annual meeting in Greenville, Ill., Jan. 8, the following directors were chosen: Thomas A. Scott, Philadelphia; Thomas D. Messler, Pittsburgh; W. R. McKeen, W. K. Edwards, Terre Haute, Ind.; Robert L.

Dulaney, Marshall, Ill.; W. S. Smith, A. G. Henry, Greenville, Ill.; Otto Brodtbeck, Highland, Ill.; J. S. Peers, Collinsville, Ill. The board subsequently elected Thomas D. Messler, President; W. H. Barnes, Treasurer; Williamson Plant, Secretary.

Upson County.—Dr. E. A. Flewellin has been elected President, and G. A. Weaver Secretary and Treasurer. Offices at Barnesville, Ga.

Wabash.—Mr. M. Knight has been appointed Assistant General Freight Agent, in place of Charles Knox, who is assigned to the department of claims.

West Chester & Philadelphia.—At the annual meeting in Philadelphia, Jan. 4, the following were chosen: President, J. Edward Farnum; Directors, Edward Hoopes, George Callaghan, Samuel J. Sharpless, William H. Miller, Charles Fairlamb, Albert C. Roberts, Samuel Riddle, Lorenzo Beck, M. B. Hickman.

Western Railroad Association.—At the annual meeting in Chicago, Jan. 8, the following directors were elected: Robert Harris, Chicago, Burlington & Quincy, B. J. Ayer, Illinois Central; A. L. Osborne, Michigan Central; Thomas Allen, St. Louis, Iron Mountain & Southern; J. D. Layng, Pennsylvania Company; F. de Funiak, Louisville & Nashville; T. F. Withrow, Chicago, Rock Island & Pacific; Charles Paine, Lake Shore & Michigan Southern; B. C. Cook, Chicago & Northwestern. Mr. Robert Harris was re-elected President; J. H. Raymond, Secretary and Treasurer; George Payson, General Attorney; Robert Harris, A. L. Osborne, B. C. Cook, Executive Committee.

Wheeling & Lake Erie.—The board has elected the following officers: President, John W. Wickham, Jr., Huron, O.; Vice-President, L. W. Sutherland, Piney Fork, O; Secretary, F. G. Lockwood, Milan, O.; Treasurer, E. A. Baker. The officers are all new except the Secretary. The presidency was offered to Mr. Joel Wood, who was President until a year ago, but he declined.

PERSONAL.

Mr. L. Burnett, for a long time Superintendent of the Sioux City & Pacific Railroad, has resigned his position.

—Mr. A. W. Hooper has resigned his position as Superintendent of the Grand Rapids, Newaygo & Lake Shore Railroad, and will accept a responsible position with the Winchester Repeating Arms Co., of New Haven, Conn. The employes of the company presented Mr. Hooper with a handsome gold-mounted cane as a parting gift.

—Mr. John C. Gault, Assistant General Manager of the Chicago, Milwaukee & St. Paul, who has been very sick at his residence in Milwaukee, is now reported by the physicians to be out of danger and in a fair way to recover.

—Mr. John G. Deshler, a director of the Columbus & Hocking Valley and Columbus & Toledo companies, and a banker of Columbus, O., died very suddenly Jan. 8.

—David E. Willard, of Oxford, has been nominated for Railroad Commissioner by the New Hampshire Republicans.

—Hon. George H. Pendleton, just elected United States Senator from Ohio, has been for a number of years President of the Kentucky Central Railroad Company.

—The New Hampshire Democratic Convention has nominated for Railroad Commissioner of that State Mr. H. B. Fowler, of Bristol.

MEETINGS AND ANNOUNCEMENTS.

Dividends.

Dividends have been declared as follows:

Illinois Central, 3 per cent., semi-annual.

Panama, 3 per cent., quarterly, payable Feb. 1.

St. Louis, Alton & Terre Haute, 2 per cent. on the preferred stock, payable Feb. 1.

East-bound Rate Meeting.

Thursday evening, Jan. 10, there was a meeting of representatives of the trunk lines and Western roads at the Brevoort House, New York, for the purpose of endeavoring to secure the maintenance of the agreed rates on east-bound traffic, which, as has been reported heretofore, have been cut for two or three weeks past. At this meeting the following were present as representatives of their respective companies:

New York Central & Hudson River, Wm. K. Vanderbilt, Second Vice-President.

Erie, H. J. Jewett, Receiver.

Pennsylvania, Thomas A. Scott, President.

Baltimore & Ohio, John W. Garrett, President.

Trunk Line Combination, Albert Fink, Commissioner.

Pittsburgh, Fort Wayne & Chicago, J. N. McCullough, General Manager.

Lake Shore & Michigan Southern, John Newell, General Manager.

Atlantic & Great Western and Cleveland, Columbus, Cincinnati & Indianapolis, J. H. Devereux, Receiver of the first-named and President of the latter.

Michigan Central, H. B. Ledyard, General Manager.

Western Lines Combination, Nathan R. Guilford, Commissioner.

The proceedings were quite harmonious, all agreeing that every effort should be made to maintain rates. The conclusions of the conference were presented in resolutions, of which the following is the substance:

The trunk lines will enforce the agreement heretofore made with the Western lines, when the complaints are communicated as provided for in the resolutions passed at the meeting of the Committee of the Western roads, viz., upon the report of the Commissioner of the Western roads; and the Western roads are earnestly requested to reinstate and maintain the regular established tariff rates from all points in the West to the seaboard cities on and after Jan. 11, on the basis of 40 cents per 100 lbs. from Chicago to New York on the fourth class. And the representatives of the Western roads present intrust their agents to restore rates as above named, and notify the managers of all the other lines not represented of their action.

The question of difference in regard to the Chicago and Milwaukee rates was referred to the two Commissioners to arrange with the interested parties.

The Western roads were fu ther requested, in case any one road, whether party to the agreement or not, is accused of cutting rates, and cannot be made to restore the same, that all the other roads will act in concert in meeting said rate when authorized through the Commissioner, the same rates to be charged by all parties.

Foreclosure Sales.

The following sales of railroad property under legal process are noted:

Ashburnham, at Fitchburg, Mass., Jan. 10, under foreclosure of mortgage. Sold to W. H. Morse, trustee for the bondholders, for $11,500. The property was afterward transferred to George C. Winchester, who had previously bought the equipment and some other property at sheriff's sale, and who was one of the principal owners. The road is three miles long, from the Fitchburg Railroad at South Ashburnham, Mass., to Ashburnham Centre; the bonded debt was $12,000 and the stock $99,370, about half of which was subscribed by the town.

Meetings.

Meetings will be held as follows:

Missouri Pacific, annual meeting, at the office in St. Louis, March 5, at noon. Transfer books will be closed from Feb. 2 to March 7.

Fitchburg, annual meeting, at the passenger station in Boston, Jan. 29, at 11.30 a. m. Besides the usual proceedings, the directors ask for authority to provide for additional terminal facilities for freight business.

Worcester & Nashua, annual meeting, in Worcester, Mass., Jan. 17, at 10 a. m.

Portland & Ogdensburg, Vermont Division, meeting of bondholders, at the Massasoit House in Springfield, Mass., Jan. 23, at 3 p. m.

Western Railroad Association.

At the annual meeting in Chicago, Jan. 8, the Secretary reported that 33 companies had joined the association during the year, making the present membership 83 companies, covering nearly half the mileage of railroad in the United States.

An assessment of $27,000 was ordered to cover the expenses of 1878. The amount of the assessment for each company will be less than for any previous year.

The following resolution was passed:

Resolved, That the members here present heartily endorse, and will, for themselves, carry out the recommendation of the executive committee that a circular be issued by the manager of each company requiring all officers and employes to submit to him, or to some other specified officer of the company, full descriptions and drawings of each improvement, no matter how trifling in devices and appliances, either made or introduced, and that that officer report the same in full to the association, together with a statement showing, if the improvement was made on the road, who was the inventor thereof, and whether he intends patenting the same, and if it is a patented improvement, the number and date of the patent covering the same.

The annual report, in a portion which will be published in full hereafter, recommends the making and preserving of complete drawings of all improvements of any value made by the men of every company, whether patented or not; and discusses the advisability of the employment of a mechanical engineer by the Association for consultation and making experiments, etc.

Further, it states that the Association is now defending the following suits: In the Supreme Court of the United States: Thomas Sayles *vs* Chicago & Northwestern, and two cases in which S. H. Turrill is plaintiff, and the Chicago, Burlington & Quincy and the Chicago & Alton defendants. In the United States Circuit Courts: James D. Mowry (S. D. Cozzens), under the extension of the Tanner brake patent of 1852 as plaintiff in nine cases, in which the Chicago & Northwestern, the Michigan Central, the Lake Shore & Michigan Southern, the Illinois Central, the Chicago, Burlington & Quincy, the Chicago, Rock Island and Pacific, the Western Union, the Chicago, Milwaukee & St. Paul and the Wisconsin Central are the defendants; also Thomas Sayles under the original term of same patent in seven cases, against as many companies; Daniel W. Vaughan, under the Hodge brake patent of 1849 in 28 cases against as many companies; Samuel H. Turrill, under the Cawood swage-block patent in seven cases; the same plaintiff, *et al.*, under the Beebe & Smith swage-block patent in four cases; Way & Parker, under the Waterbury coupler patent, for an alleged infringement by the use of the Miller coupler, against the Flint & Pere Marquette; George Herrick, under his patent for improvement in wrecking cars, against the Western & Atlantic; Kirby & Dick, under the Kirby patent for utilizing exhaust steam for feed-water heating, against the Terre Haute & Indianapolis; and Samuel Noblet, under the Noblet (star) nut-lock washer patent, against the Ohio & Mississippi.

TRAFFIC AND EARNINGS.

Railroad Earnings.

Earnings for various periods are reported as follows:

	1876-77.	1875-76.	Inc. or Dec.	P. c.
Year ending Oct. 31:				
North Pennsylvania..	$1,482,705	$1,675,866	Dec.. $193,161	11.5
Expenses	920,659	889,347	Inc.. 31,312	3.5
Net earnings	$562,046	$786,519	Dec.. $224,473	28.5
Earnings per mile..	16,811	21,499	Dec.. 4,688	21.8
Per cent. of exps..	62.09	53.07	Inc.. 9.02	17.0
West Chester & Philadelphia	332,274	369,545	Dec.. 37,271	10.1
Expenses	178,700	201,576	Dec.. 22,876	11.3
Net earnings	$153,574	$167,969	Dec.. $14,395	8.6
Earnings per mile..	9,360	10,410	Dec.. 1,050	10.1
Per cent. of exps...	53.78	54 55	Dec.. 0.77	1.4
Year ending Nov. 31:				
Lehigh Valley	$6,488,037	$7,049,647	Dec.. $561,610	8.0
Expenses	3,162,822	3,842,750	Dec.. 679,928	17.7
Net earnings	$3,325,215	$3,206,897	Inc.. 118,318	3.7
Earnings per mile..	22,219	24,143	Dec.. 1,924	8.0
Per cent. of expenses.	48 75	54.51	Dec.. 5.76	10.6
Philadelphia & Reading	$12,142,910	$12,227,511	Dec.. $84,601	0.7
Expenses	7,751,693	8,510,320	Dec.. 758,657	8 9
Net earnings	$4,391,217	$3,717,161	Inc.. $674,056	18.1
Earnings per mile..	15,307	15,413	Dec.. 106	0.7
Per cent. of exps...	63.84	69.60	Dec.. 5.76	8.3
Year ending Dec. 31:	1877.	1876.		
Central Pacific	$16,676,107	$18,146,944	Dec.. $1,470,837	8.1
Denver & Rio Grande..	781,265	469,991	Inc.. 311,274	66.2
Hannibal & St. Joseph	2,014,867	1,877,695	Inc.. 137,172	7.3
Indianapolis, Bloom. & Western	1,207,662	1,462,804	Dec.. 255,142	17.4
Paducah & Memphis.	189,583	207,473	Dec.. 17,890	8.6
Pittsburgh, Virginia & Charleston	$129,019	$127,739	Inc.. 1,280	1.0
Expenses	90,910	87,393	Inc.. 3,517	4.0
Net earnings	$38,109	$40,346	Dec.. $2,237	5.6
Earnings per mile...	3,395	4,258	Dec.. 863	20.3
Per cent. of exp's...	70.47	68.28	Inc.. 219	3.2
St. Louis & San Francisco	1,320,453	1,336,469	Dec.. 16,016	1.2
Eleven months ending Nov. 30:				
Bur., Cedar Rapids & Northern	$1,120,327	$1,037,583	Inc.. $82,744	8.0
Net earnings	367,377	235,813	Inc.. 132,564	56.2
Per cent. of exps...	67.23	77.39	Dec.. 10.16	13.1
Cleve., Mt. Vernon & Delaware	354,869	345,874	Inc.. 8,995	2.6
Net earnings	1,783	67,901	Inc.. 13,882	20.4
Per cent. of exps...	76.93	80.34	Dec.. 3.41	4.3
Dakota Southern	191,357	185,116	Inc.. 6,241	3.4
Kansas Pacific	3,036,442	2,783,872	Inc.. 252,570	9.1
Net earnings	1,298,700	1,180,178	Inc.. 118,522	10.0
Per cent. of exps....	57 24	57.60	Dec.. 0.36	0.6
Mobile & Ohio	1,675,823	1,789,704	Dec.. 113,881	6.4
Nash., Chattanooga & St. Louis	1,586,144	1,558,680	Inc.. 27,464	1.8
Net earnings	635,701	584,702	Inc.. 50,999	8 7
Per cent. of exps....	59 93	62 47	Dec.. 2.54	4.1
Paducah & Memphis..	170,151	190,369	Dec.. 20 218	10.6
Net earnings	54,841	47,019	Inc.. 7.822	16.6
Per cent. of exps....	67.83	75.45	Dec.. 7.62	10.1
St. Louis, Iron Mt. & Southern	3,974,117	3,494,280	Inc.. 479,837	13.7
Net earnings	1,864,322	1,441,842	Inc.. 422,480	29.3
Per cent. of exps....	53.09	58.74	Dec.. 5.65	9.6
St. Paul & Sioux City.	493,276	534,328	Dec.. 36,052	6.7
Net earnings	183,062	208,552	Dec.. 25,550	12,2
Per cent. of exps....	63.31	61.01	Inc.. 2.30	3.8
Sioux City & St. Paul.	308,895	334,820	Dec.. 25,925	7.7
Net earnings	97,062	107,394	Dec.. 10,332	9.6
Per cent. of exps....	68.55	67.89	Inc.. 0.66	1.0
Southern Minnesota..	622,107	581,133	Inc.. 40,974	7.1
Net earnings	265,462	196,092	Inc.. 69,370	35.4
Per cent. of exps....	57.34	66.27	Dec.. 8.93	13.5
Union Pacific	11,547,350	11,895,872	Dec.. 348,522	2.9
Net earnings	6,708,914	6,874,945	Dec.. 166,031	2.4
Per cent. of exps....	41.92	42.21	Dec.. 0.29	0.7
Six months ending Sept. 30:				
New York & Manhattan Beach	$66,685	.....	.....	....
Net earnings	21,287	.....	.....	....
Per cent. of exps...	68.16	.....	.....	....
Month of October:				
Erie	$1,535,343	$1,647,885	Dec.. $112,522	6.8
Net earnings	604,553	775,578	Dec.. 171,025	22.1
Per cent. of exps....	60.57	52.93	Inc.. 7.64	14.4
Month of November:				
Great Western, of Canada	$365,600	$335,200	Inc.. $30,400	9.1
Net earnings	105,100	67,900	Inc.. 37,200	54.8
Per cent. of exps....	71.14	79.74	Dec.. 8.60	10.8
Galveston, Harrisburg & San Antonio	104,701	120,878	Dec.. 16,177	13.4
Mobile & Ohio	252,766	284,590	Dec.. 31,824	11.2
Month of December:				
Central Pacific	$1,347,000	$1,424,317	Dec.. $77,317	5.4
Denver & Rio Grande.	73,017	41,415	Inc.. 31,602	76.3
Hannibal & St. Joseph	136,492	132,117	Inc.. 4,375	3.3
Ind., Bloom. & Western	93,117	113,656	Dec.. 20,539	18.1
Paducah & Memphis.	19,432	17,104	Inc.. 2,328	13.6
St. Louis & San Francisco	108,542	112,294	Dec.. 3,752	3.3
First week in January:	1878.	1877.		
Atchison, Topeka & Santa Fe	$35,825	$25,411	Inc.. $10,414	41.0
St. Louis, Iron Mt. & Southern	81,600	92,476	Dec.. 10,876	11 8
Week ending Jan. 4:				
Great Western, of Canada	$89,090	$65,614	Inc.. $23,476	35.8
Week ending Jan. 5:				
Grand Trunk	$150,191	$101,693	Inc.. $48,498	47.7

Coal Movement.

The anthracite tonnage reported for the first week in January is: 1878, 247,548; 1877, 132,408; increase, 115,140 tons, or 87 per cent.

It is reported that a basis of combination has been reached which the Lehigh Valley Company will accept, and that the combination of the anthracite companies will be completed very shortly. The division of business agreed upon is stated as follows:

	Per ct. of total production.
Philadelphia & Reading	28 62500
Lehigh Valley and individual Lehigh operators	19.75000
Central of New Jersey	12.90625
Delaware, Lackawanna & Western	12.75000
Delaware & Hudson Canal Co.	12.46875
Pennsylvania Railroad Co.	7 62500
Pennsylvania Coal Co.	5.87500
Total	100.00000

On a basis of 20,000,000 tons annually, this would give the Reading 5,725,000 tons; Lehigh Valley, 3,950,000; Central of New Jersey, 2,581,250; Delaware, Lackawanna & Western, 2,550,000; Delaware & Hudson, 2,493,750; Pennsylvania Railroad, 1,525,000; Pennsylvania Coal Co., 1,175,000.

Further complete reports of anthracite tonnage for the year ending Dec. 31 are as follows:

	1877.	1876.	Inc. or Dec.	P. c.
Delaware & Hudson Canal Co.	1,929,348	2,006,509	Dec.. 77,261	3.9
Central of N. J., Lehigh Division	2,969,788	2,952,521	Inc.. 17,267	0.6
Delaware, Lackawanna & Western	2,320,637	2,300,500	Inc.. 20,136	0.9

The tonnage of the Huntingdon & Broad Top Railroad for the year was:

	1877.	1876.	Inc. or Dec.	P. c.
Broad Top	140,143	129,789	Dec.. 19,646	12.3
Cumberland	187,488	145,797	Inc.. 41,691	28.6
Totals	327,631	305,586	Inc.. 22,045	7.2

The actual tonnage of the Pennsylvania & New York road for December was as follows:

	1877.	1876.	Decrease.	P. c.
Anthracite	60,351	65,459	5,108	7.8
Bituminous	31,087	35,578	4,491	12.6
Totals	91,438	101,037	9,599	9.5

The tonnage report of the Chesapeake & Ohio Railroad for the year ending Dec. 31 as given last week did not include coke. The full report for the year is as follows:

	1877.	1876.	Inc. or Dec.	P. c.
Coal, cannel	42,000	52,980	Dec.. 10,980	20.7
Coal, splint and bituminous..	245,995	194,660	Inc.. 51,335	26.4
Coke, main line and branches	36,070	28,535	Inc.. 7,535	26.4
Totals	324,065	276,175	Inc.. 47,890	17.3

Receipts of coal at Chicago for the calendar year are reported as follows:

	1877.	1876.	Increase.	P.c.
By lake	750,421	697,757	52,664	7.5
By rail and canal	984,727	921,276	63,451	6.9
Totals	1,735,148	1,619,033	116,115	7.2

Anthracite forms the chief part of the lake receipts.

Shipments out of the pools on the Monongahela River above Pittsburgh during 1877 were 2,908,112 tons of coal and 6,778,118 bushels of coke.

Shipments of coal from the mines about Seattle, Wash. Ter., for the year were: 1877, 112,734 tons; 1876, 104,556 tons; 1875, 70,157 tons; increase, 1877 over 1876, 8,178 tons, or 7.8 per cent.; increase, 1877 over 1875, 42,577 tons, or 60.6 per cent. Of this coal not less than four-fifths went to San Francisco, one-tenth to Southern California, Oregon and Sandwich Islands, and one-tenth was consumed at home.

Grain Movement.

Receipts and shipments of grain of all kinds for the week ending Jan. 5 were, in bushels:

	1878.	1877.	Inc. or Dec.	P. c.
Northwestern receipts	1,452,608	2,195,445	Dec.. 742,837	33.7
" shipments	1,012,056	938,244	Inc.. 73,812	7.8
Atlantic receipts	2,764,984	1,412,388	Inc..1,352,596	95.8

The receipts at the Northwestern markets are the smallest for six years, the shipments thence are above the average for the same period, and the receipts at Atlantic ports were never before so large for the corresponding week.

Of the latter, 38.7 per cent. was at New York, 20.9 at Philadelphia, 20.9 at Baltimore, 8.7 at Boston, 8.7 at New Orleans, 1.9 at Portland, and 0.2 at Montreal. The accumulations of stocks at the various markets are now unusually small—Jan. 5 this year, 24,578,989 bushels, against 31,641,076 in 1877 and 27,529,448 in 1876. The grain seems to go forward as soon as it reaches the Northwestern markets and to be exported or distributed as soon as it reaches the seaboard.

East-Bound Rates from Milwaukee.

At a meeting held in Chicago, Jan. 14, for the purpose of

settling the question as to the rates from Milwaukee to Eastern points, it was decided, after some discussion, to make all-rail rates from Milwaukee to points on the seaboard the same as from Chicago.

OLD AND NEW ROADS.

Buffalo Pipe Line.

Application has been made to the New York Legislature to charter the Buffalo Pipe Line Company, with authority to build an oil-pipe line from Buffalo to the Pennsylvania State line.

Cairo & St. Louis.

The Receiver is negotiating with the city authorities of Cairo, Ill., for a new entrance into that city. The old line is too liable to damage from high water in the Mississippi, having been washed away several times already.

Central, of New Jersey.

A joint meeting of the committees representing the bondholders, the stockholders, the floating debt creditors and the Lehigh & Wilkesbarre bondholders, was held in New York, Jan. 15, to consider the various plans of reorganization proposed. The stockholders' committee presented a plan providing for a recognition of the claims of the Lehigh & Wilkesbarre and the American Dock & Improvement bonds. After some discussion it was resolved to appoint a subcommittee of eight, consisting of two members of each of the committees represented, to consider the various schemes that have been proposed to reorganize the New Jersey Central Company, and report a plan at a future meeting. The Chairman subsequently appointed J. S. Kennedy, J. Edgar Johnson, E. M. Lewis, George S. Coe, Thos. Cochran, Geo. G. Haven, Jacob Vanatta and Geo. Manly.

Connecticut Valley.

Holders of a majority of the first-mortgage bonds have petitioned the State Treasurer of Connecticut, as provided by law, to take possession of this road and work it in their interest; also to proceed to foreclose the first mortgage as soon as the year required by law expires, provided the company does not, before that time, pay up all arrears of interest. The Treasurer has not yet taken action on the petition, but is expected to do so in a few days.

Concord.

This company has made a general reduction in the wages of its employes, giving a reduction of business and earnings as the reason.

Delaware, Lackawanna & Western.

The Scranton (Pa.) *Republican* says: "Having been repeatedly asked, during the past month, whether it is a fact that the Delaware, Lackawanna & Western Company is coercing its engineers into singing a contract severing their relations with the Brotherhood; and whether men were being discharged because of refusals to so sign: we answer, as we did upon a previous occasion, no. We speak authoritatively. That contract was drawn neither at the solicitation, dictation, nor by authority of the company. The company has not asked any nor urged any to sign it; has not threatened to discharge nor has it discharged any for not signing it. We have access to the paper. It expressly states that 'we *voluntarily* agree' to do thus and so. It orginated with members of the Brotherhood, and because they were disapp inted in the results of an organization that they claim does not fulfill the promise of its origin, and had become a draft upon them which was not borne without more sacrifice than the end attained warranted. Men have been discharged, not because they would not sign such paper, but because shipments have decreased, and fewer men are needed In diminishing the force employed, the company has done just as any individual would do—selected those whom i could best dispense with. Some of them have been re-employed as firemen, and the others have not been told that they will not be re-employed when needed. There has been no hint at coercion, whatever, and the paper has been signed by a large majority of the engineers, not only voluntarily, but eagerly. We stated this once before less explici ly, perhaps, and were still asked the questions appearing in the first lines of this item. Sure then, we are surer now in making a negative reply. It is a Brotherhood matter, and but for the necessity forced upon us by the public talk, would not meddle with it now, and don't want to do so again."

Chesapeake & Ohio Canal.

This company has applied to the Maryland Legislature for an authority to issue $500,000 of first lien bonds to enable it to raise funds to repair the damage done the canal by the recent floods The act of 1844 authorized the board to borrow money without limiting the amount, and the question has arisen as to which of the bonds issued under this law have the priority as regards payment In order to place the standing of the new issue beyond cavil, the Legislature will be requested to limit the issue to the amount as stated above, and also give the priority over all previous issues in the matter of payment. Arrangements have been made already by the board for placing about $200,000 of the bonds, but it is thought that not more than $100,000 would be required at this time, and in this case but that amount of bonds would be issued.

Detroit & Milwaukee.

Receiver Trowbridge's statement for December is as follows:

Balance Dec. 1	$49,049 91
Receipts from operating road	102,068 83
Total	$151,118 74
Disbursements	87,715 38
Balance Jan. 1, 1878	$63,403 36

The Receiver's indebtedness Jan. 1 was $357,598.70.

Erie.

Argument on the motion to enjoin James McHenry and his associates from continuing their suits, after continuing nearly all of last week, was closed Jan. 12, the Court reserving its decision on this motion, and on several others recently urged in the McHenry suits, and also in some intervening petitions in the foreclosure suits.

The Receiver has filed a formal account covering the period from May 25, 1875, to Dec. 31, 1876. This is the separate account in the original suit, required by the Attorney General

Elberton Air Line.

This road is now graded for the entire distance from Elberton, Ga., northwest to the Atlanta & Charlotte Air Line at Toccoa City, 60 miles. It is said that an offer has been received from parties who will supply the iron, if the people along the line will find the ties.

Flint & Pere Marquette.

It is reported that the Vanderbilt interest is trying to secure a controlling interest in this road, the object being to use it as a line to Lake Michigan and to Milwaukee in the interest of the Canada Southern.

Fond du Lac, Amboy & Peoria.

There has been a contest for the possession of this road between Mr. H. W. Boardman, President and Manager, and Judge Kinyon, who claims to have been chosen Superintendent by the board. The opposite party held that there had been no legal meeting and took measures to dispossess Kinyon, who was running the road. At latest accounts the property was in the possession of the United States Marshal, and it was expected that the Court would appoint a receiver.

Gilbert Elevated.

In the suit of the Sixth Avenue Railroad Company against this company, the New York Supreme Court at General Term has decided that there was no such invasion or destruction of the Sixth Avenue road and franchise shown as entitled the company to compensation under the constitutional provision that no private property should be taken for public use without just compensation, because no part of the Sixth Avenue Company's road, as it has been constructed and now exists, will be in any way disturbed or interfered with by the execution of the plan upon which the Gilbert Company is about to build; and because its vested rights and franchises will not be interfered with thereby. The Court also holds "that the plaintiff has no easement or property right in the roadway of Sixth avenue, incident or appurtenant to its ownership of lands abutting thereon, the beneficial use or enjoyment whereof will be destroyed, diminished, impaired or interfered with by the construction or operation of the defendant's proposed railway."

Grand Trunk.

This company has given notice of application to the Canadian Parliament for an act authorizing it to lease certain other railroads in Canada and the United States; also for authority to organize a benefit or insurance association or fund for its employes.

Indianapolis, Bloomington & Western.

Receiver Wright reports as follows for the five months ending Nov. 30:

Balance, July 1		$9,120 37
Receipts from operating accounts		603,089 58
Receiver's certificates		217,915 93
Total		$830,125 88
Pay-rolls, vouchers, etc	$615,902 80	
Receiver's certificates paid	141,699 25	
		757,601 05
Balance, Dec. 1		$72,523 83

The receipts were $63,403 46 in excess of the disbursements, but the current receipts were $12,813.22 less than the current disbursements, $76,216.68 having been received on certificates in excess of the amount paid on the same.

Internal Revenue Penalties Recovered.

In the United States Circuit Court, in Philadelphia, Jan. 12, Judge McKennan, on motion of James E. Gowen, in various suits brought against Collectors of Internal Revenue, entered judgments on special verdicts which had been rendered for the plaintiffs. This was in consequence of a recent decision of the Supreme Court of the United States, which rules the question raised by the verdicts. The suits were brought to get back penalties exacted from the following railroad companies: Philadelphia & Reading, $27,445.98; Catawissa, $2,604.13; Philadelphia, Germantown & Norristown, $136,43; East Pennsylvania, $870.57. East Mahanoy, $78.36; Huntingdon & Broad Top, $850 11, and Philadelphia, Wilmington & Baltimore, $2,184 24.

James River & Kanawha Canal.

At a called meeting of stockholders in Richmond, Va., Jan. 9, estimates were presented of the cost of repairs of the canal and also estimates of the cost of a railroad from Buchanan to Richmond. The majority of the committee of stockholders reported that the damage to the canal by the recent freshets was so great that the company could not repair it, and recommended an application to the cities of Richmond and Lynchburg and the counties along the line for funds. This was set aside and a minority report adopted, which recommended that the company apply to the Legislature for authority to operate the canal from Richmond to Lynchburg and abandon it beyond Lynchburg; also that the Buchanan & Clifton Forge Railroad be extended from Buchanan to Richmond, or such point between Lynchburg and Richmond as the means available may allow. Some suggestions as to the necessary charter amendments were offered and referred to the directors. The city of Richmond and about four-fifths of the private stockholders voted in favor of the majority proposition to repair the canal, but the city of Lynchburg and the State of Virginia voted for the minority report or railroad proposition.

Menominee River.

Trains are now running regularly on this road from the junction with the Chicago & Northwestern near Spaulding, Mich., 22 miles westward to the Quinnesec Mine, a distance of 26 miles. The road is owned by the Chicago & Northwestern and is built for the purpose of carrying iron ore from the Breen, Brietung and Quinnesec mines in the Menominee iron district.

Missouri, Iowa & Nebraska.

The contract for the use of the St. Louis, Keokuk & Northwestern track from Alexandria, Mo., to Keokuk, Ia., provides that this company shall pay one-half the cost of maintenance and a rental equal to 8 per cent. on one-half of an appraised valuation of the road. The company is also to pay one-half the cost of the Buena Vista bridge, payment to be made in 36 installments with interest. There is still some difference between the two companies as to details.

Nashville & Tuscaloosa.

A meeting in aid of this road was held in Nashville, Tenn., last week, and resolutions were passed recommending subscriptions to the stock. The road is to run from Dickson, Tenn., on the Nashville, Chattanooga & St. Louis, southward to Tuscaloosa Ala., and the company is now trying to raise money to build a section of 20 miles from Dickson.

New York, New Haven & Hartford.

At the annual meeting in New Haven, Jan. 9, Mr. Goodwin, of East Hartford, offered again the resolution he has presented every year for some time past directing the officers of the road to issue no passes to members of the Legislature and not to allow them to ride at lower rates than ordinary passengers. An amendment was offered leaving the whole matter to the discretion of the board, and the resolution as amended was passed.

New Jersey (United).

The Philadelphia *Ledger*, speaking of the Longstreet stock, upon which proceedings to set aside the lease to the Pennsylvania Railroad Company were based, says: "Some six months ago they were, by tempting offers, induced to sell their stock and its equities to Mr. Andrew Carnegie, but no transfer of the same was made upon the books of the company until within the present week, when, we are informed it was made, and, the payment of all dividends due upon the shares, amounting to some $15,000 was demanded This, it is supposed, is the last of any effort to invalidate the lease of the United Companies of New Jersey to the Pennsylvania Railroad Company, the only remaining act to a finality being the dismissal of the case from the court docket a Trenton"

Ohio & Mississippi.

Receiver King's statement for December is as follows:

Balance Dec. 31	$38,428 70
Receipts for the month	375,178 75
Total	$413,607 45
Disbursements	315,951 48
Balance, Jan. 1, 1878	$97,655 97

The receipts were $59,227.27 in excess of the disbursements.

Pennsylvania.

The Pittsburgh *Telegraph* says: "The Pennsylvania Railroad Company is determined to put a stop to professional tramping, at least so far as the thoroughfare of that corporation is concerned, as they believe that if the free transportation of tramps by railroad could be prevented, one-half the evil would thus be abated. The board of directors recently instructed their General Manager to take effective measures for the suppression of the evil along twenty miles of their road as an experiment, and, following out these instructions, four prison cars have been placed at different points of the road, on the sidings. The Executive Committee recommend that the local associations give such aid as may be in their power to the officers of the railroad company, and urge them to see that proper and efficient officers, especially justices of the peace and constables residing at accessible points, be elected at the spring elections for the several districts."

The Philadelphia *Times* of Jan. 14 says: "Mr. John Fallon, counsel for a number of those having claims against the Pennsylvania Railroad, arising out of losses by the Pittsburgh riots, has filed his claims in the United States Circuit Court, where the matter is to be tested. The first batch of eighteen cases will be tried as a whole. * *

"There are a large number of cases yet to come, but by an agreement between Mr. Fallon and Hon. Wayne MacVeagh, representing the Pennsylvania Railroad Company, these cases have been placed on file for the purpose of testing the law in the matter. Nearly all these suits are for goods in transitu westward, held to have been destroyed in the yard of the Pennsylvania Company, at Pittsburgh, during the great fire on the 29th of July last. The allegation of the plaintiffs is that on the Saturday afternoon previous to the fire a number of the strikers waited upon the officials of the Pennsylvania Railroad Company, and stated the great danger which freight massed in the yard was in in case the rioters became demonstrative, and offered to remove the cars out of the city to a place of safety. This, it is alleged, was declined by the Pennsylvania Company officials, who informed the strikers that unless they would agree to work at the reduced rate of compensation offered, they should not touch the cars. The strikers refused to accept the terms of the company, and during the night oil trains were set on fire, and the cars sent in among the other freight cars, causing a great destruction of property, by which the plaintiffs suffered. During the progress of the fire, it is alleged, the strikers, contrary to the orders of the company officials, saved a number of cars and their contents. With these facts as a basis of the suit the matter was taken at once to the United States Court for the purpose of reaching a prompt decision.

"There are other claimants anxiously awaiting these decisions, as it is thought the result here will establish a precedent for other cases."

Pittsylvania.

Arrangements are being made to build a narrow-gauge road from Crider's Mill, in Pittsylvania County, Va., to Sycamore on the Virginia Midland, a distance of about seven miles. The object of the road is to open up a large deposit of iron ore.

Philadelphia & Reading.

At the annual meeting in Philadelphia, Jan. 14, the following resolutions were adopted:

1. *Resolved*, That the report of the board of managers be, and the same is, hereby accepted and adopted, and that it, together with the accompanying reports and exhibits, be printed in pamphlet form, for distribution among the stockholders.

2. *Resolved*, That the issue of 6 per cent. scrip, payable in 1882, for the purposes set forth in the report, and the execution of the deed of trust of 27th June, 1877, to Robert McCalmont, Richard Potter and Thomas Wilde Powell, in trust for the holders of the general mortgage, the improvement mortgage, and the Perkiomen sterling bonds, be hereby ratified and approved.

3. *Resolved*, That the recommendations of the board of managers with reference to the amount to the credit of sinking fund bonds purchased and canceled, and to the renewal fund, are hereby approved, and that the powers and authorities conferred upon and granted to the board of managers by the resolutions passed at prior annual meetings be, and the same are, hereby continued.

4. *Resolved*, That a vote of thanks be and the same is hereby presented to the President and board of managers, for the able manner in which the business of the road has been conducted during the past year.

A sharp little discussion took place, after the reading of the report, between Mr. Charles E. Smith and one or two others. Finally, on motion of Mr. Smith, seconded by Mr. Franklin B. Gowen, it was:

Resolved, That a committee of three stockholders be appointed by the meeting to investigate the condition of its accounts and affairs, especially as to the truth or untruth of the statements made by Mr. Charles E. Smith, with power to send for persons and papers.

The committee appointed consists of D. B. Cummings, E. S. Whelen and Joshua Lippincott.

Quincy, Missouri & Pacific.

Contracts have been let for the grading of six miles of the extension from Kirksville, Mo., westward The surveys are in progress and more contracts will be let as soon as the location is completed

Richmond, Fredericksburg & Potomac.

The case of this company against the city of Richmond, Va., was argued before the United States Supreme Court last week. It is of considerable importance, and involves the question whether it is within the police power of the State to restrict chartered privileges. The charter of the road permitted it to run through Broad street, of the city, but the corporation has by ordinance prohibited the use of steam in propelling cars along that street, insisting that the condition upon which the social compact rests reposes in its authorities the trust of protecting the life and property of the citizens by such measures as are needful for that purpose, and that the prohibition in this case is essential to the public safety, and therefore lawful and valid.

Richmond & Danville.

Damages from the late freshets had hardly been repaired, when a new freshet, on Jan. 11, again carried away the temporary bridge over Staunton River. Passengers are transferred by ferry, but freight traffic will be stopped for several days.

Spartanburg & Asheville.

The grading on this road is now completed from the terminus at Tryon City, S. C., northward seven miles to Pan's Gap, and the tracklayers have begun work on this section. From Pan's Gap to Green River, three miles, is a section containing some heavy work, but the company has a large force of convicts employed and expects to have the grading done next spring. From Green River to Butt Mountain Gap, another heavy section of four miles, the contractors, Rice & Coleman, have but a few weeks' work left. From Butt Mountain Gap to Hendersonville, N. C., the road-bed is all ready for the ties. Should no unexpected obstacle arise the company will have the 18 miles from Tryon City to Hendersonville in operation early next summer. A very good business is reported on the completed section from Spartanburg to Tryon.

Toledo, Peoria & Warsaw.

The Receiver's report for the three months ending Dec. 31 is as follows:

Balance on hand Oct. 1		$23,301 54
October receipts from all sources		147,912 10
November " " "		116,260 29
December " " "		120,260 70
Total		$407,734 63
Disbursements for October	$141,405 34	
" " November	110,514 61	
" " December	131,137 25	
		383,057 20
Balance, Jan. 1, 1878		$24,677 43

In October the receipts exceeded the disbursements by $6,506.76; in November by $5,745.68; in December the disbursements were $10,876.55 more than the receipts, leaving the receipts for the three months $1,375.89 in excess of the disbursements.

United States Rolling Stock Co.

The London committee of shareholders report that the estimated gross earnings for the four months ending October last were:

	1877.	1876.
July	$48,031	$49,634
August	57,220	50,437
September	47,017	51,292
October	52,066	51,049
Total	$204,334	$202,412

In 1876 the company was able to let all its passenger cars for the latter part of the Centennial season at enormous prices, and there was for part of the time a full demand for its freight cars. In 1877 the demand was chiefly for freight cars, but that was very active after harvest.

Upson County.

At the annual meeting of this company last week President Wadley of the Central of Georgia was present and offered on behalf of that company to surrender the road and furnish an engine and cars, if the company would agree to keep the road in operation and pay off the taxes due. The stockholders, however, voted to decline this offer. The road is 16 miles long, from Barneville, Ga., to Thomaston, and has been worked by the Central at a loss.

Vermont Valley.

It is stated that this company has begun a suit in Boston to recover $128,000, of which $36,000 is for rental due and unpaid, $80,000 for property turned over at the time of the original lease of the Valley road to the Rutland Company, and the balance damages for failure to keep the road in good condition. Central Vermont funds in Boston banks have been attached. The complaint also represents that the Central Vermont Company is insolvent and asks for a receiver.

Washington City, Virginia Midland & Great Southern.

The bridge over Staunton River, between Lynchburg, Va., and Danville, partially carried away by the recent freshets and since replaced, was again carried away by a freshet on Jan. 11, temporarily stopping freight traffic on the road.

Western, of North Carolina.

This company has resolved to have a survey made of the extension of the road from Egypt, N. C., to Greensboro, and also to build a stockade and make other preparations to employ the convicts allotted to the company by the State. The distance from Egypt to Greensboro is 51 miles.

Wisconsin Central.

As noted last week, the United States Circuit Court granted the application of certain judgment creditors of the Phillips & Colby Construction Company for a receiver for that company. Subsequently the Court appointed Robert Wasson Receiver, and ordered that he should have power to examine the books of the Wisconsin Central Company.

Mr. Wasson subsequently refused to accept the receivership. A cross-bill has been filed in the suit, alleging that the plaintiffs, Seymour, Alexander & Co., secretly bought up contracts held by other parties, and asking that the Court investigate these alleged purchases.

RAILROAD LAW.

Maryland Taxation Cases.

The annual message of the Governor of Maryland gives the following particulars as to a number of contested cases in that State relating to the taxation of railroad property:

"I communicate the following information in reference to proceedings in the courts to which the State is a party:

"On March 2, 1876, the Court of Appeals decided that the shares of stock of the Northern Central Railway Company were not exempted from taxation by this State, and that the act of 1872, chapter 234, imposing a tax upon the gross receipts of railroad companies was a valid act.

"This decision practically affirmed the validity of the act of 1874, chapter 408, which also imposed a tax upon the gross receipts of railroad companies.

"On June 23, 1876, the same court decided that the gross receipts of the Philadelphia, Wilmington & Baltimore Railroad Company from that part of its line which extends from the city of Baltimore to the Susquehanna River were liable to taxation by this State.

"In a proceeding instituted under my direction by the Attorney General, the same Court decided, on March 1, 1877, that the conveyance made by the Cumberland & Pennsylvania Railroad Company of its railroad to the Consolidation Coal Company was unauthorized by law; that the ownership and control of said railroad remained in the Cumberland & Pennsylvania Railroad Company, and that the act of 1876, chapter 64, amending the charter and regulating the tolls of that company was a valid act.

"The questions relating to the Baltimore & Ohio Railroad Company, referred to in resolutions Nos. 12 and 13 of the General Assembly of 1876, have been brought to the attention of the courts by the Attorney General in suits instituted against that company for the recovery of the tax upon its gross receipts imposed by the acts of 1872, chapter 234, and 1874, chapter 408. One of these suits, selected as a test case, is now pending in the Court of Appeals.

"The Baltimore & Ohio Railroad Company, relying upon decisions of the Court of Appeals made in 1848, sustaining the exemption of its property and stock from taxation, resists the payment of the tax in question. These decisions were made several years before the Baltimore & Ohio Railroad was completed to the Ohio River, and before the company had acquired many of the rights and a large proportion of the property which it now holds and uses. It remains for the Court of Appeals to determine what portions of the property, if any, now in the possession, or which may come into the possession, of that company, are, or will be, within the reach of the taxing power of this State.

"The counsel who were appointed by his excellency Governor Bowie, in 1870, under resolution No. 7, of the session of that year, have fully performed the duties imposed upon them by that resolution, and by the act of 1876, chapter 139.

"The Court of Appeals and the Supreme Court of the United States have both sustained the validity of the contract between the State and the Baltimore & Ohio Railroad Company, under which the company was required to pay into the treasury of the State one-fifth part of the whole amount received by it for the transportation of passengers between Baltimore and Washington.

"The proportion of this money accruing to the State prior to Jan. 1, 1870, was collected by the counsel appointed in that year, and paid into the treasury during the administration of Governor Groome. The same counsel, during my administration, have obtained judgments in the Circuit Court for Howard County for the State's proportion of such money from Jan. 1, 1870, to July 1, 1875, amounting in the aggregate to $828,488.84, and which bears interest from April 10, 1876. They have also obtained judgment in the Superior Court of Baltimore city for the State's proportion of the same money from July 1, 1875, to Jan. 1, 1876, amounting to $53,505.78, bearing interest from Dec. 21, 1876.

"The judgment in one of the cases in the Circuit Court for Howard County was selected for appeal as a test case and has been affirmed, upon full consideration, by the Court of Appeals. The company, exercising a proper right, is endeavoring to obtain a review of this judgment by the Supreme Court of the United States. It is believed that the controversy will end speedily, and that the judgments obtained by the State will be left in full force. In such event, of course, no further obstacle will be interposed by the company to the enforcement of the contract referred to, if the State shall determine to maintain it in its present form."

The Governor adds that the Baltimore & Ohio has expressed informally a desire to adjust amicably its differences with the State.

ANNUAL REPORTS.

Philadelphia & Reading.

The following figures and statements are from President Gowen's report for the year ending Nov. 30, 1877. The detailed reports and tables of the Treasurer, General Manager, Chief Engineer, etc., are not yet published.

No change in the mileage worked is noted: it consists of 98.4 miles of main line and 228.6 miles of branches owned; 416.4 miles of branches leased and 56.4 miles controlled, being 799.8 miles in all.

The earnings for the year were as follows:

	1877.	1876.	Inc. or Dec.	P. c.
Travel	$1,610,050	$2,433,685	Dec. $823,635	33.8
Merchandise	2,913,588	2,949,501	Dec. 35,913	1.2
Coal	7,505,207	6,708,682	Inc. 796,525	11.9
Mail	41,587	54,484	Dec. 12,897	23.7
Miscellaneous	72,478	81,159	Dec. 8,681	10.7
Gross receipts	$12,142,910	$12,227,511	Dec. $84,601	0.7
Gross expenses	7,751 693	8,510,350	Dec. 758,657	8.9
Net profits	$4,391,217	$3,717,161	Inc. $674,056	18.1
Per cent. of expenses	63.8	69.6	Dec. 5.8	8.3

The receipts and expenses per passenger and per ton, including renewal funds, rent of laterals, taxes, etc., were as follows:

	1877. Receipt.	1877. Cost.	1876. Receipt.	1876. Cost.
Per passenger	$0.241	$0.166	$0.223	$0.162
Per ton of merchandise	1.027	0.638	1.183	0.794
Per ton of coal, including tonnage of main line and branches only	1.271	0.818	1.451	1.029
Per ton of coal, including tonnage of laterals	1.034	0.666	1.199	0.850

The above statement includes all expenditures except interest on funded debt. Excluding all charges other than the proper working expenses, the result would be:

	1877. Receipt.	1877. Cost.	1876. Receipt.	1876. Cost.
Per passenger	$0.241	$0.122	$0.223	$0.119
Per ton of merchandise	1.027	0.449	1.183	0.563
Per ton of coal, including tonnage of main line and branches only	1.271	0.583	1.451	0.741
Per ton of coal, including tonnage of laterals	1.034	0.475	1.199	0.612

As condensed from the transportation and income account, the result of the year's business may be stated as follows:

Receipts over cost of working the road		$3,391,217 47
Profit on steam colliers		240,731 50
State tax on dividends refunded, profit on line of Richmond coal barges, etc., less depreciation in value of materials and drawbacks on traffic of 1876		95,167 03
		$4,727,116 00
From which deduct—		
Loss upon the business of the Schuylkill Canal	$248,656 72	
Less profit upon the business of the Schuylkill Canal Transportation Line	74,901 73	
	$173,754 99	
Loss upon the business of Susquehanna Canal	180,339 21	
		354,094 20
		$4,373,021 80
From which deduct—		
Interest on bonded debt	$4,185,221 50	
Interest on bonds and mortgages	112,664 36	
Debit balance of interest account	238,586 54	
		4,536,472 40
Debit balance for year charged to profit and loss		$163,450 60

"It will be seen that the result of the year's business of the railroad company, after payment of all rentals of leased lines and charging off the losses upon the canals, has been, exclusive of sinking fund charges, $163,450.60 less than the amount of the fixed charges for interest account; but as in the above statements the full amount of interest and rentals is charged as if paid in cash, and as by the operations of the funding scheme, hereafter to be referred to, $863,125.50 of the said amounts were payable in scrip, it follows that the net result of the year's business of the railroad company shows a profit of $699,674.90, more than sufficient to meet all fixed charges which by the terms of the funding scheme were payable in cash.

"Upon the opening of business in the spring of the past year, when it became apparent that another season of active competition and disastrous prices was to result from the inability of the representatives of the several coal interests of Pennsylvania to agree upon some plan for the management of the anthracite coal trade, it was thought advisable by the Board of Managers to make a proposition to the holders of the later securities of the company to fund all or a portion of their interest and rentals for a term of years, so that in any event the company might weather the storm and carry all of its vast property intact safely through whatever period of depression it might yet be compelled to encounter."

The report then gives the particulars of the funding agreement, which were stated at the time. The total amount of scrip to be issued is $8,157,165, and the relief afforded to the company was $903,707.50 in 1877. It will be $1,881,165 in 1878; the same in 1879; $1,585,875 in 1880; $1,256,835 in 1881, and $828,417.50 in 1882. This includes the accounts of the railroad company and those of the coal and iron company, the Perkiomen Railroad and the Schuylkill and Susquehanna canals. The report says:

"Of the above amount there had been actually issued in scrip prior to the close of the fiscal year $6,097,396.40, of which amount $1,803,000 had been converted into income mortgage bonds, leaving outstanding $4,294,396.40 of scrip, which several amounts will correspond with those in the balance sheet; while up to Jan. 10, 1878, the entire amount of scrip issued was $6,379,433.50, of which amount $1,842,000 had been converted into income mortgage bonds. Apart from the protest of a few coupons by a bank holding them for collection, no attempt has been made by any bondholder to enforce the payment of his coupons, and the managers have rigidly and in good faith adhered to the pledge made on their behalf at the London meeting, to treat all bondholders exactly alike.

"As compared with the floating debt of $8,272,359.33, reported at the last annual meeting, the floating debt of both companies, at the close of business on the 12th of January, 1878, was $6,674,980.52, of which sum, $175,325 is represented by bills receivable with good security, discounted for the company, but included in the floating debt out of abundant caution in anticipation of the debtors requiring additional time on the maturity of the obligations, and a further account of $519,893.42 represents loans made upon coal and iron now on hand, and of greater market value than the debt secured by the pledge.

"The managers have therefore fulfilled their promise to reduce the floating debt by at least the amount of relief obtained from the funding scheme, and in view of the larger amount of such relief to be obtained during the coming year, it is confidently expected that before its expiration the floating debt will be further reduced to the extent of very nearly $2,000,000, no matter what may be the prices obtained for coal or the rates received for transportation.

"Referring to the income statements and the general balance sheet, it will be seen that the amount charged to profit and loss, viz.: $1,519,159.18, representing the loss of $1,355,708 for 1876, and $163,450.60 for 1877, can at any time be overbalanced by the credit on the other side of the ledger of $1,571,200 representing that amount of the funded debt of the company actually paid and cancelled by the operations of the sinking funds and charged to income account in previous years; and in lieu of reserving this credit as the basis of a distribution of stock, as has been done heretofore, the Managers recommend that it be used to wipe out the amount standing to the debit of profit and loss as the result of the business of the last two years.

"It will be observed that there has been no charge or addition to the capital of the company for the last year, as all new work done by the railroad company has been charged to renewal fund, which, computed at the rate of 5 cents per 100 tons of cargo carried one mile, was amply sufficient for the purpose. During the periods of high prices the renewal fund was calculated as well upon the weight of the cars as of their cargo, but in view of the great reduction in the cost of rails and other materials, and of the increase in the traffic of the company, it is recommended that hereafter this fund shall be based entirely upon the actual tonnage moved irrespective of the weight of the cars themselves.

"Apart from the issue of the scrip and income mortgage bonds, the only changes made in the funded debt of the company during the year have been the extension for five years, or until 1882, of the $134,400 bonds which matured July 1, 1877, the cancellation of $3,100 of debenture bonds received, according to the conditions thereof, for freight, and the cancellation of $1,000 of the consolidated mortgage loan for the sinking fund.

"The following table will show the volume of traffic for the last four years, the great increase of passenger in 1876 having been due to the Centennial Exposition held in Philadelphia in that year. The coal traffic for 1877 has been larger than ever before carried, while the aggregate tonnage of all kinds, 11,833,826, has only been once exceeded in the previous history of the company, and excluding from the comparison of that year the excess of company's materials then carried, the paying tonnage of the past year has been the largest ever known:

	1874.	1875.	1876.	1877.
Number of passengers carried	6,964,869	6,938,129	10,936,157	6,674,889
Number of tons of coal, 2,240 lbs	6,348,812	5,505,455	5,595,207	7,255,318
Number of tons of merchandise, 2,000 lbs	3,098,831	2,720,208	2,493,277	2,837,648
Number of tons of company's materials, 2,000 lbs	493,591	581,984	482,222	313,981
Total tonnage of company (2,000 lbs.), including weight of passengers and company's materials	11,336,261	10,099,040	10,336,326	11,833,826

"With reference to the several branch lines and the auxiliary business of the railroad company, it may be said that as compared with last year, the Catawissa Railroad lease shows a gain of $12,804.64; that the Germantown & Norristown Branch, while earning a profit above the rental paid for it, has not done so well as in previous years, principally due to the stagnation of manufacturing industry along the Norristown line; that the business of the Perkiomen Railroad shows an increase, and that after payment of the rental of the Lancaster & Quarryville Railroad, of which it is the lessee, the Reading & Columbia Railroad has done better than in any other year.

"The express business has resulted in a net profit of $55,181.13 as against $62,239.40 for the preceeding year, and the managers are gratified in being able to report that, after so many years of activecompetition, the Adams Express Company has agreed to withdraw from the express business in the local territory and along the lines of the company, and to maintain rates with the company at all competitive points reached by other lines of railroad over which it is a transporter.

"The line of steam colliers has yielded a net profit of $240,731.50 for the year, after charging to expense account $73,800 for insurance fund, which is now in credit $276,014.03."

The report gives the usual table of rail renewals. The worn out rails taken out last year were 5,116¼ tons. Of the rails laid in 1868, in all 55.2 per cent. have since been replaced; 1869, 31.2 per cent.; 1870, 26 per cent.; 1871, 15.7 per cent.; 1872, 15.1 per cent.; 1873, 14.3 per cent.; 1874, 8.8 per cent.; 1875, 6.2 per cent.; 1876, 1.1 per cent, and of those laid in 1877, 0.5 per cent.

The report then speaks at length of the locomotive engineers' strike and also of the strikes of last summer, concluding as follows:

"It is believed that the outbreak at Martinsburg was a premature one, made in advance of the time determined upon by the principal leaders of the movement; and though it is partly due to this fact that the frightful scenes of Pittsburgh were not enacted over the whole country, as the result of a fully organized and preconcerted movement, there can be no doubt whatever that the Philadelphia & Reading Railroad Company owes its exemption from the evils of a protracted strike to the promptness with which, three months before, it had rid itself of the last vestiges of trade unionism by its successful conflict with the Brotherhood of Locomotive Engineers.

"The stockholders are to be further congratulated upon the fact that the past year has witnessed the downfall of another secret association which for so many years held the entire anthracite coal region in bondage. The infamous Molly Maguire society, so far as the Schuylkill and Lehigh regions are concerned, may now be considered as effectually disbanded. In June last ten of the principal assassins belonging to the association were hanged, and six more, including three of the most prominent leaders, are now in jail awaiting the execution of sentences of death.

"With trades-unionism broken, and the Molly Maguire order destroyed and disbanded, the company can hope to succeed in its efforts to establish friendly personal relations with its employes, and the men themselves will hereafter be relieved not only from the physical danger which ever threatened their per-

sons and property if they violated the orders of the leaders of the secret tribunals, but also from the unfair suspicion with which they were regarded by many of the general public, too often unable to distinguish the great number of innocent from the guilt few.

"It is certainly due to the 23,000 employes of the two companies to say that it would be difficult to find anywhere a more orderly, respectable or better-behaved body of men, and the company has every reason to feel highly gratified at the fact that, during all the disorders of last July, no single man left the service of the railroad company; while during the same period in the Schuylkill coal region, which had once been the theatre of such appalling crimes, not only were the services of the military never required, but all the local militia and numbers of the police force of the region left the district and were actively engaged in maintaining peace of the Commonwealth in other portions of the State."

COAL & IRON COMPANY.

"The total tonnage of the estates of the Coal & Iron Company for the year was 5,183,637 4/5 tons, of which there were mined by the company 3,794,528 1/2 tons, and by tenants 1 389,-108 7/20 tons.

"The following general income account shows the result of the business of the year:

Here follows a statement showing—

Gross expenses	$10,584,847 34
Less gross receipts	10,0 7,031 94
	$577,815 40

"This loss of $577,815.40 is further increased to $755,478.37 by the following items, principally of depreciation of stock and materials and equipment as per inventory of Nov. 30, 1877. * *

"The interest account of the Coal & Iron Company for the year was $1,020,378.26, including therein the amount paid in the scrip of the railroad company. * *

"The actual cost of mining, preparing and delivering coal into the railroad cars for the year was $1.02 6/7 per ton, but as this sum includes the cost of all new work and improvements done and erected in the year, all of which have been charged to working expenses, the actual cost of mining was less than $1.00 per ton, and fully as low as the stockholders were led to expect by the report read at the last annual meeting. The tonnage from the lands was larger than could reasonably have been expected, and the only disappointment in the business of the year has been in the prices realized for the product. Up to the 1st of June, notwithstanding the large output of all the companies, the prices of coal, though extremely low, were maintained at such a figure as realized a moderate royalty upon each ton mined, but in consequence of the large quantity of coal thrown upon the market about the 1st of June, by the action of some of the New York companies, one of which upon a falling market forced auction sales of the production of two months in advance, the price fell fully 50 cents per ton, and to a point from which there was but little recovery even during the curtailment of production resulting from the strikes in the Wyoming region, and which was still further lowered upon the resumption of mining in the fall, until at the November auction sale of the Delaware, Lackawanna & Western Railroad Company in New York, the price fell to the lowest point ever reached in the history of the trade.

"Notwithstanding, however, the bad result of the business of the Coal & Iron Company, when it is considered that that company paid to the railroad company for coal freights alone over $5,000,000 in cash, and that the general merchandise and passenger receipts of the latter company were greatly increased by the business resulting from the large product of coal, it is evident that the profits of the railroad company from the business of the Coal & Iron Company so greatly exceed the losses of the latter, that taking into consideration the low prices and depressed condition of business, the joint result of the operations of the two companies must be considered as favorable as could have been expected.

"It is certain that all that is now required to obtain good results is a fair price for coal, and when it is known that if the price obtained during the last year had been equal to the lowest average price of any year in the previous history of the trade, the company would have made a large profit for the stockholders, it will surely be considered unfair to measure the value of its estates by the meagre results of such exceptional times."

The report then refers to the late negotiations for placing the anthracite trade under a Board of Control, ending in the acceptance by the company of an allotment of 28⅝ per cent. of the total production. This was believed to be less than the company was justly entitled to, but it was thought best to yield the difference in order to secure the advantages of combination. Last year's prices averaged about $1 less than any previous year, and it is believed that an average increase of that amount per ton will enable the company to resume dividends.

In conclusion the report says:

"Before concluding this report, it is proper to refer to certain statements recently published by Charles E. Smith, a late director and former President of the company, in which it is charged that dividends have been made which were not earned, that the existence of the floating debt was concealed from him until the month of November, 1876, that the full amount of the floating debt at various times was not properly reported to the authorities of the State, and that improper transfers of the floating debt were made from the books of the railroad company to those of the Coal & Iron Company.

"The categorical answers to these several charges are:

"1st. It is not true that any dividends were made which were not earned, except upon the hypothesis that it was necessary to reserve the actual profits of the railroad company which were due to its stockholders for the purpose of paying the interest upon the cost of the property of the Coal & Iron Company, pending the period of the investment of the money for its purchase and the improvement and development of the estate, which interest was, in every respect, an entirely proper charge to the capital of the Coal & Iron Company.

"2d. It is not true that the existence of the floating debt was ever attempted to be concealed from Mr. Smith, or that it was at all unknown to him until November of 1876. Mr. Smith was at all times fully cognizant of it, took part time and again at meetings at which its existence and extent were discussed, and on or about the first day of October, 1876, when the President of the company was in the city of New York, engaged in negotiations with creditors for the extension of the floating debt, and when the amount of such debt had become, as it were, the public property of the newspapers, Mr. Charles E. Smith was in the office of the company in Philadelphia awaiting with anxiety, which if not felt was at least well simulated, the arrival of a telegraphic dispatch from the President announcing the success of his mission.

"3d. It is not true that the exact amount of the floating debt of the railroad company was not properly returned at all times to the authorities of the State, and the so called discrepancies alleged in Mr. Smith's statement are made up by including other items, principally advances on account of purchase of bonds, which in no sense whatever constituted the floating debt of the railroad company.

"4th. The so-called improper transfer of floating debt from the books of the railroad company to those of the Coal & Iron Company was simply placing upon the books of the latter company the bills payable issued by it for its use, and which it was primarily liable to pay. The fact that to give credit to and increase the market value of such paper it had been accepted by the railroad company, who placed their name upon it for the benefit of the Coal & Iron Company, did not require that the bills issued should be entered as bills payable upon the books of both companies, thereby doubling the amount of obligations actually outstanding, and as it was proper that this paper should be upon the books of that company primarily liable for its payment, and for whose benefit it was issued, the transfer was entirely right and proper; but when it became necessary for the Reading Railroad Company to negotiate with the creditors of both companies for an extension of time for the payment of the floating debt the whole of the indebtedness was assumed by the railroad company and at once entered upon its own books.

"The managers of the company are well aware that, as they act in a fiduciary capacity, it becomes their duty to answer all charges which may be make against the integrity of their management, irrespective of the source from whence they came or the motive which actuates him who gives them utterance; and though it is not intended to make the annual meeting of shareholders the arena for any personal disputes or discussions, the managers cannot but give utterance to the conviction that forces itself upon them, that if Mr. Charles E. Smith, for eight years a President and for six years a manager of, and during the entire latter period in close personal relations with that particular officer who had charge of accounting department, and who had been his own confidential clerk, knew nothing of the financial condition of the company, he has been guilty of such shameful imbecility and incapacity that the stockholders are to be congratulated that his place in the board has been filled by one who is not likely ever to put in a plea of ignorance in order to shield himself from responsibility; but if, on the other hand, Mr. Smith, knowing full well the condition of the company, and having taken advantage of his early knowledge of its affairs to sell the majority of his own stock at high prices, and being grievously disappointed in an attempt made by him to change the management at the last election, has either out of personal revenge or for any motive joined the enemies of the company with a view to injure its credit, then, in the opinion of all honest men, he must be classed among those who are not permitted to take refuge in the sanctuary of folly to escape from the stigma of their proper designation."

Chesapeake & Ohio.

The tenth annual report of this company covers the year ending Sept. 30, 1877, during which the road was in the hands of a Receiver (who is also Vice-President of the company). A decree of foreclosure has been granted, and the road is to be sold thereunder on April 2. The road owned and worked is as follows:

	Miles.
Main line, from Richmond, Va., to Huntington, W. Va., including extension to James River in Richmond	4.7.82
Lowmoor Branch	2.18
Quinnimont Branch	1.50
Coal River Branch	1.33
Morris Creek Branch	1.81
Total	434.64

The branches all serve coal mines or iron furnaces; the Morris Creek Branch was built during the last year, the owners of the land doing the grading.

The equipment consists of 77 locomotives; 29 passenger, 4 sleeping and 16 baggage, mail and express cars; 730 box, 86 stock, 332 flat and gondola, 693 eight-wheel coal, 252 four-wheel coal, 11 coke rack and 50 conductors' cars; 1 officers' and 1 pay car, 4 derrick, 58 shanty and 137 gravel cars.

The liabilities of the company are as follows:

Stock subscribed and paid in ($36,698 per mile)		$15,950,401 96
Bonds of 1854 and 1855 and other prior lien bonds	$1,512,578 90	
Six per cent. bonds of 1870	14,992,0 6 00	
Seven per cent. bonds of 1872	11,374,000 00	
Total bonded debt ($64 119 per mile)		27,878,578 90
Floating debt		2,274,491 04
Total ($106,068 per mile)		$46,103,371 90

There is also reported $3,172,200 preferred stock subscribed for but not issued. The floating debt includes $380,241.18 income bonds issued for floating debt and funded coupons. In addition to the 7 per cent. bonds above noted, there are $800,000 of these bonds pledged as security for $571,267.11 of the floating debt. The opposite side of the account is in the somewhat intricate and obscure form required, we believe, by law in Virginia, but there does not appear to be any considerable amount invested in anything outside of the road and equipment.

The earnings for the year were as follows:

	1876-77.	1875-76	Inc. or Dec	P. c.
Passengers	$338,672 98	$365,865 41	Dec. $7,192 43	2.0
Freight	1,285,184 51	1,177,942 36	Inc. 107,242 15	9.1
Express and mail	80,188 47	83,340 87	Dec. 3,152 40	5.9
Telegraph and miscellaneous	8,486 79	2,363 91	Inc. 6,122 88	259.0
Total	$1,702,532 75	$1,599,512 55	Inc. $103,020 20	6.4
Expenses	1,363,.24 86	1,243,035 95	Inc. 120,188 91	9.7
Net earnings	$339,307 89	$356,476 60	Dec. $17,168 71	4.8
Gross earnings per mile	3,925 17	3,695 48	Inc. 229 69	6 2
Net earn. per mile	782 27	8 3 59	Dec. 41 32	5.0
Per cent. of exp	80.07	77.72	Inc. 2.35	3.0

Included in expenses are $14,243.03 paid for steel rails, and $22 864.28 for rebuilding engines. The net earnings above were sufficient to pay only 1.22 per cent. on the funded debt, or 0.74 per cent. on the entire stock and debt.

The work done for the year was as follows:

	1876-77.	1875-76.	Inc. or Dec.	P. c.
Miles run by passenger trains	515,523	622,398	Dec.. 106,873	17.2
Miles run by freight trains	1,390,964	1,145,218	Inc.. 245,746	21.5
Miles run by service trains	106,453	113,050	Dec.. 6,592	5.8
Total	2,012,947	1,880,666	Inc.. 132,281	7.0
Mileage of passenger tr'n cars	2,357,5'5	.....	.....	....
Mileage of freight cars	22 365,033	.....	.....	....
Passengers carried	160,554	189,950	Dec.. 29,396	15.5
Passenger mileage	8,910,:38	9,737,982	Dec.. 827,744	8.5
Tons freight carried	471,660	415,461	Inc.. 56,198	13 5
Tonnage mileage	116,948,585	97,901,135	Inc..19,047,450	19.5
Av. pass. train load, No.	17.28	15.65	Inc.. 1.63	10.4
Av. fr'ght train load, tons	84.08	85.49	Dec.. 1.41	1.6
Av. No. pass. cars p'r train	4.57	.....	.....	....
Av. No. fr't cars per train	16.08	.....	.....	....
Receipts per train mile	87 41 cts.	.....	.....	....
Net earn. per train mile	15.91 "	.....	.....	....
Av. receipt per passenger per mile	3.81 "	.....	.....	....
Av receipt per ton per mile	1.10 "	.....	.....	....

The through freight carried was 61,696 tons eastward and 9,373 tons westward. The tonnage carried was divided as follows: Products of the forest, 43,985 tons; products of mines (chiefly coal and coke), 272,311 tons; products of animals, 26,030 tons; vegetable food, 32,102 tons; other agricultural products (chiefly tobacco and cotton) 21,589 tons; manufactures, merchandise and miscellaneous (including 17,586 tons of oil), 75,693 tons; total 471,660 tons. More than one-third of the freight car mileage was of empty cars.

The low average freight rate per mile reported is probably due to the fact that the through business was done at extremely low rates. Much of the coal business must also be done at very moderate rates to enable the West Virginia coal to compete with others in Eastern markets. The advertised rates on coal to Richmond are little over one cent per ton per mile, and in some cases vary with the prices of coal, and a higher rate would doubtless be prohibitory for much of his traffic.

The Receiver's current account, condensed, is as follows:

Cash on hand from last report		$33 679 93
Amount received from uncollected earnings, rents, etc.		116,065 36
Old accounts, prior to receivership		4,805 16
Earnings of road, less amount uncollected		1,624,821 80
Due for supplies included in disbursements		82,986 45
Total		$1,862,358 70
Bills payable, personal accounts, etc	$64,875 72	
Unclaimed wages and back pay-rolls	68,613 74	
Equipment	75,514 81	
Wood, coal, etc	2,241 05	
Construction	77,340 85	
Land damages	5,197 77	
Pay-rolls, September, 1876	64,219 98	
Coal shipments	44,294 83	
Expenses of foreclosure suits and New York office	47,870 77	
Personal accounts and bills receivable	39,779 93	
Working expenses, less September pay-rolls	1,297,934 57	
		1,787,884 02
Balance		$74,474 68

Of this balance $55,396.82 is in cash and $19,077.86 in bills receivable and personal accounts due.

During the past year 30½ miles of road were relaid with steel rails and 48¼ miles with iron; 186,623 new ties were used. The Morris Creek Branch, 1.81 miles, was built, and 9¾ miles of new sidings laid. The coal and iron interests are improving and the freight business increased, in spite of a four months' strike of the miners in the Kanawha Valley.

The obligation of the company to pay taxes on the road from Richmond to Covington having been established by the United States Supreme Court, a compromise was arranged by which the State of Virginia agreed to accept $96,261.16 in full for all taxes due, including those of 1877. This amount was paid, $80.000 of it having been raised by the issue of Receiver's certificates. The work of the Committee of Purchase and Reconstruction has been delayed by litigation over this and some other matters, but it is not believed that the sale will now be delayed beyond next April.

Northeastern (South Carolina).

This company owns and works a line from Charleston, S. C., northward to Florence, 102 miles. It is equipped with 13 locomotives; 13 passenger and 5 mail and baggage cars; 87 box and 55 platform cars. The report is for the year ending Sept. 30, 1877.

The general account is as follows:

Capital stock		$899,350 00
Preferred stock		88,000 00
Total stock ($9.680 per mile)		$987,350 00
Bonds ($10,353 per mile)		1,056,000 00
Real estate bonds		28,000 00
Certificates of indebtedness		57,222 31
Interest outstanding		28,2.9 01
Balance of open accounts		4,565 00
Profit and loss		57,840 96
Total ($21,757 per mile)		$2,219,203 00
Road and equipment ($21,060 per mile)	$2,148,130 65	
Real estate	23,998 99	
Stocks and bonds	19,301 46	
Bills and accounts receivable	9,051 41	
Cash	18,725 49	
		2,219,208 00

Of the bonds $820,000 are first-mortgage and $234,000 second-mortgage bonds and $2,000 old bonds never presented for payment; $88,000 second-mortgage bonds are also held by the trustees as security for the equal amount of preferred stock. The certificates of indebtedness are payable 10 per cent. yearly. During the year all the bills payable, $33,370, were paid off, leaving none of that class of debt. The company is endorser on $40,000 of 8 per cent. bonds of the Ashley River Railroad, just completed.

The earnings for the year were as follows:

	1876-77.	1875-76.	Inc. or Dec.	P. c.
Passengers	$72,503 85	$97,674 64	Dec.. $25,170 79	25.8
Freight	233,662 46	271,904 02	Dec.. 38,241 56	14.1
Mails	13,103 00	14,700 26	Inc.. 1,304 74	9.5
Total	$32 ,0.1 31	$382,278 92	Dec.. $62,9 7 61	16.3
Expenses	192,038 37	2.0,435 05	Dec.. 28,396 68	12.9
Net earnings	$128,032 94	$161,843 87	Dec.. $33,8 0 93	20.9
Gross earn per mile	3,140 60	3,747 83	Dec.. 607 23	16.2
Net earn. per mile	1,255 22	1,586 60	Dec.. 331 48	20.9
Per cent. of expenses	60.00	57.66	Inc.. 2.34	4.1

The income account is as follows:

Net earnings		$128,032 94
Interest on debt and current interest	$99,844 45	
Taxes (as called for)	4,872 52	
New passenger coach	3,875 80	
Old claims adjusted	1,159 28	
		109,752 05
Surplus for the year		$18,280 89
Sale of tools and materials at Florence	$14,723 48	
Less discount on bonds sold	5,950 94	
		8,772 54
Balance from previous year		30,787 53
Balance at close of year		$57,840 96

The decrease in revenue resulted from low rates on through business caused by competition, and from an actual loss of traffic. Some figures for the traffic of the road are:

	1876-77.	1875-76.	Inc. or Dec.	P.c.
Passengers carried	38,8:7	53,157	Dec. 14,330	26.9
Bales cotton carried	16,683	26,7.8	Dec. 10,025	38.1
Barrels naval stores carried	138,3:5	1.9,587	Inc. 3,798	2.9

Both gross and net earnings are the smallest since 1872. The road, however, carried more cotton last year than in any previous year except 1875 and 1876, and more naval stores than in any previous year. The expenses were cut down to the lowest point consistent with the safe operation of the road. The company needs more passenger cars and also some new ones to replace some of the older ones which are of old patterns and nearly worn out: also some new box cars, to reduce the present enforced use of foreign cars. The shops at Florence, temporary wooden buildings put up towards the close of the war, have been abandoned, and the work is now done in the new shops of the Wilmington, Columbia & Augusta at the same place, which are better supplied with tools. It is believed that the change will result in greater economy in repairs.

The rails are in very fair order. As the old iron rails wear out, they are being replaced by steel rails with approved joints.

The report refers to the Ashley River Railroad, the completion of which is noted elsewhere, and to the aid extended to its construction by endorsing its bonds; also to the advantages expected from the direct connection thus established with the Savannah & Charleston road. The road would have been opened in November, had it not been for the legal delays caused by the attempt of the South Carolina Railroad Company to prevent a crossing of its track.